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THE RECLAMATION ERA

JANUARY 1940

The Budget

{Fiscal Year 1941}

The President's Budget, as submitted to the Congress, suggested appropriations totaling $45,019,600 for the Bureau of Reclamation for the 1941 fiscal year, which includes the period from July 1, 1940, to June 30, 1941. A summary of the Budget proposals follows:

ESTIMATES OF APPROPRIATION

Fiscal Year 1941

General Public Works Program

	Budget Allowances
Reclamation fund:	
Colorado-Big Thompson project, Colorado	$2,000,000
Pine River project, Colorado	200,000
Uncompahgre project, Colorado	75,000
Boise project, Idaho	700,000
Sun River project, Montana	50,000
Carlsbad project, New Mexico	50,000
Rio Grande project, New Mexico	72,000
Deschutes project, Oregon	400,000
Provo River project, Utah	750,000
Yakima project, Washington	500,000
Kendrick project, Wyoming	500,000
Riverton project, Wyoming	200,000
Shoshone project, Wyoming	350,000
General investigations	300,000
Administrative expenses	750,000
Total, Reclamation fund	6,897,000
Advances to Colorado River Dam fund:	
Boulder Canyon project	4,000,000
All-American Canal	1,000,000
Reclamation fund—Continued	
Operation and maintenance:	
District of Columbia, salaries and expenses	$150,000
Examination and inspection	5,000
Yuma project, Arizona	70,000
Boise project, Idaho	65,000
Minidoka project, Idaho	11,600
Buffalo Rapids project, Montana	25,000
Rio Grande project, New Mexico	30,000
Owyhee project, Oregon	115,000
Klamath project, Oregon-California	68,000
Yakima project, Washington	250,000
Kendrick project, Wyoming	0
Riverton project, Wyoming	45,000
Shoshone project, Wyoming	13,000
Secondary projects	25,000
Operation and maintenance administration	35,000
	907,600
General fund:	
Colorado River front work and levee system	15,000
General fund:	
Construction:	
Parker Dam power, Arizona-California	3,500,000
Central Valley project, California	16,000,000
Grand Coulee Dam project, Washington	12,000,000
Administrative expenses	700,000
Total	32,200,000
Grand total, construction	44,097,000
Grand total for Bureau of Reclamation	45,019,600

PRICE
ONE
DOLLAR
A YEAR

THE RECLAMATION ERA

VOLUME 30 • JANUARY 1940 • NUMBER 1

The Domestic Sugar Problem

By CHARLES M. KEARNEY, *President, National Beet Growers' Association* [1]

THE topic you have asked me to discuss is The Domestic Sugar Problem. I might ask, which one? The problems are many and varied. The outstanding problem of our sugar beet farmers is, How can I meet the interest and principal due on my obligations to creditors, pay my current grocery and store bills, educate and clothe my children, and, in general, maintain a 1939 and 1940 American living standard for my family? But I shall discuss a phase of the problem pertaining to western reclamation.

Of course, the first problem that the pioneer irrigator faces is the problem of getting water to his land in sufficient quantities for the production of satisfactory crops. However, after this has been done, he soon discovers that his troubles are not over, for he must then grow crops which will provide sufficient revenue to take care of the overhead expenses that are inherent in irrigated agriculture. The standard crops will not do the job, and through a process of trial and error, the sugar beet crop has been found to be a major crop grown in the temperate zone of the United States that makes possible the solvency of western irrigated agriculture. It is proper that at any meeting of the National Reclamation Association the sugar beet crop should have a part, and I am most pleased that at this particular meeting you have given it so much time on your program.

Those projects where the sugar-beet crop is already established are naturally anxious to protect that crop and to insure its future prosperity, while those newer projects, where the industry has not yet been established, are anxious to secure its establishment. At this particular time I am president of the National Beet Growers Association, which is composed of some 32,000 beet growers living in our irrigated valleys from the Pacific coast to the Missouri River, in which territory is grown more than 80 percent of the beet sugar produced in the United States. The efforts of this association have always been directed to the end of helping the sugar-beet industry. We have tried in every possible way to cooperate with all of the other interests whose purpose has been the same as ours, namely, the building up of a sound and profitable sugar-beet industry in the United States and, through that industry, the building up of our western irrigated agricultural economy.

Notes

Cover: **Lake Chelan, Washington**

Proceedings of the National Reclamation Association and other addresses were carried in the December 1939 issue of The Reclamation Era.

The industry has shown a continual growth—sometimes fast, sometimes slow. At the beginning of the World War in 1914, about 600,000 tons of beet sugar were produced in the United States, while the crop of 1939 is estimated at 1,650,000 tons sugar raw value. Approximately 1,000,000 acres were devoted to growing sugar beets in 1939. The growing of this sugar-beet acreage resulted in the employment of many thousands more workers in growing the crop than would have been used if other crops had been grown on the same acreage. Thousands of men were employed in the beet-sugar factories of the land during the sugar-making campaign. Railroads and trucks were busy hauling the beets and sugar, and workers in coal mines, lime quarries, and cotton fields and factories of the South had employment because of the American beet-sugar industry.

Governmental Protection

Many times I have been asked, Why does the American beet-sugar industry need governmental protection? My answer has been, "In order to protect farmers and workers therein so that they may maintain American standards of living." The sugar that comes into the American market in competition with continental-grown beet sugar is largely produced under tropical conditions, where daily wages are but a fraction of what the American beet farmer and manufacturer pay. In fact, a study of relative daily wages paid in one of the large producing areas that furnishes a good portion of the American supply of sugar would indicate that these wages were not more than one-fourth of what is paid in the American beet-sugar industry, both farm and factory.

Some have charged the American beet sugar industry with being inefficient. I have always resented that accusation. I challenge anyone to name any major crop produced in the temperate zone that produces more human food per acre than sugar beets. I think it can also be truthfully stated that the American farmers and workers in the field and workers in the factory produce more sugar per unit of time than anywhere else in the world. If we then consider the definition of efficiency to be that scheme which produces a unit of product with a minimum expenditure of human labor, the American beet sugar industry is the most efficient industry in the sugar-producing world. The governmental protection afforded the American sugar industry is not to protect an inefficient industry, but it is a part of an historic and sound policy having for its main objective the stabilizing of the industry so that fair profits will be returned to farmers, workers, and the industry for services rendered.

During most of the history of the beet-sugar industry, this governmental protection took the form of a protective tariff. Since 1934 to the present time, the industry has been operating with nominal tariff protection and under a quota system which prorated to the various sugar-producing areas a certain definite portion of the American sugar market. It was expected that this quota plan would prevent an oversupply of sugar being brought into the American market and thereby maintain prices, which would make it possible for American beet growers and the industry to continue operation and at the same time pay the relatively high wages that are necessary under our American scheme of things. Our association had a part in helping frame this type of legislation.

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[1] Address delivered before the National Reclamation Association at Denver, November 16, 1939.

Operation of Sugar Act of 1937

The enactment of legislation frequently results in a compromise between the views of the different parties interested. This was true of the Sugar Act of 1937. We were not entirely satisfied with the provisions of that act, but we did feel that it held out hope, if sympathetically administered, of at least maintaining the domestic sugar industry in a reasonably profitable condition. Sugar farmers have expressed dissatisfaction and disappointment with the administration of the sugar act and with the actual results that have been attained. Consumptive estimates have been made at such levels that prices of sugar during the past 2 years have been at a very low level. As you know, under the Sugar Act of 1937 a processing tax of approximately 53½ cents per hundred pounds of sugar is collected on each bag of sugar sold in the United States, and a part of the funds so collected has been paid to sugar farmers for their cooperation in the program. In 1932 sugar reached the *lowest retail price* in our history, when it sold to consumers at an average of 5 cents per pound. In the months of February, March, and April 1939, in spite of the fact that there was a 53½-cent processing tax on sugar and a sugar control program being administered by the Secretary of Agriculture, the retail price to consumers in the United States was 5.1 cents per pound, or just one-tenth cent per pound above the *all-time low price.* There is but one other country where shoes are worn on week days with a comparably low price on sugar.

With the unjustifiably low sugar prices prevailing, disappointingly low returns have been received by our farmers for their sugar beets. Initial payments made to our growers on their 1939 crop of sugar beets have been disappointing and discouraging throughout the West. Low sugar prices and the uncertainties in the future sugar situation probably brought this about. Under terms of grower-processor purchase contracts sugar prices and sugar beet prices are directly connected.

The Sugar Act of 1937 expires next year, and it will be necessary for new sugar legislation to be passed by the incoming Congress. I do not know what form that sugar legislation will take, nor am I prepared to advocate what form it should take. With the uncertainties of the world situation, the removal of the quotas on September 11 by Presidential proclamation, and the consideration of reduction in the Cuban tariff, the various interests have been unable to crystallize their thinking and to come to a definite conclusion as to what should be done. I am hopeful that in the next month or two this crystallization will come about and that we shall be able to present to our representatives in Congress a program that will assure a sound and prosperous American beet sugar industry.

Importance of the Sugar Beet

I shall close this discussion by briefly summarizing some of the reasons why we must maintain and expand the highly important sugar beet industry in our western irrigated valleys.

1. Without the sugar beet industry and the corollary livestock feeding industry, the present population and social and educational standards of the West cannot be maintained, most certainly not increased.

2. There is no other crop that can be substituted for sugar beets.

3. The sugar beet industry uses more labor than any other major agricultural product grown on a commensurate acreage in the United States.

4. The average gross return for sugar beets in Nebraska in 1936 was $66.47, in Utah $80.90, and in Colorado $74.67. This does not include value of tops. Average gross return from grains and other large scale crops was less than $20 per acre. None of these returns yielded satisfactory profits, but they are illuminating.

Grand Coulee Dam, Columbia Basin project, Washington. Eight million cubic yards of concrete had been placed in the dam on November 1, 1939, representing four-fifths of the entire bulk to be contained in the structure upon completion

U. S. Docs. Ref.

5. In the number of the agricultural population sustained per acre the sugar beet States compare quite favorably with other sugar producing areas of the world. Sugar beet lands serve the related agricultural population in far greater measure than do the corresponding lands in other areas.

6. The beet growers form only a small percentage of those interested in the beet sugar industry. Whole communities enjoy a higher standard of living directly by reason of the crop.

7. Both beet growing and processing are carried on in rural communities, so the industry fosters a stable farming community.

8. Many Federal reclamation projects already in operation but not paid out, as well as new ones that have been authorized, will not be successful and some would probably fail without the sugar beet industry.

9. Studies have shown that a much larger percentage of beet farmers pay taxes than any other farm group in beet-growing areas.

10. Without the industry, land values would shrink to such low values that many mortgages, as well as county, school district, and municipal bonds, held by savings banks and insurance companies and other investors, could not be paid.

Various Government credit agencies, such as the Federal land banks, the Agricultural Credit Corporation, the Land Bank Commissioners, etc., would find loans uncollectible.

11. Elimination or serious reduction in capacity of the beet sugar industry would destroy large amounts of invested capital and cause hardship and injustice to many investors, large and small.

12. The sugar producing States offer a stable and assured market for eastern manufactured goods. They offer a far better market than any foreign overseas' producers would be if we purchased all our sugar from them. The capacity of the people of the sugar beet States to consume products from other areas would be enormously reduced if any other known use was made of sugar beet lands.

13. An increasingly substantial part of our sugar requirements should be grown in continental United States to protect America against loss of supply in times of war or other emergencies.

14. It is probable that if no beet sugar industry existed, United States consumers would be paying substantially more for sugar than they now are.

We have problems—tough ones, and plenty of them. We will carry on until they are solved and we have permanent prosperity. But after all, they are killing "over there." We play games—football, baseball, golf, and all the rest, and fraternize with our friends and neighbors in meetings and conferences such as this. We have America and our West, and we will make them better.

Commissioner Page Honored

THE annual election of officers held at the November meeting of the District of Columbia section of the American Society of Civil Engineers, resulted in the election of John C. Page, president; Clifford A. Betts, vice-president; Benjamin E. Jones, secretary; and John D. Fitch, treasurer.

Sugar Beet Acreage on Reclamation Projects

By HON. JAMES F. O'CONNOR, *Member of Congress from Montana* [1]

THIS great Nation of ours is confronted today with some of the most difficult domestic problems it has ever faced. I am not reciting platitudes nor am I merely taking up your time with idle words when I say that before the United States are domestic problems greater than we have ever faced before.

Consider first that our national debt is literally within inches of its towering 45 billion dollar limit, and consider also that despite this staggering debt, much of which was spent to bring about a national recovery, we still have millions of deserving people out of work.

Are not these two almost terrifying national problems, which some of us see as imminent threats to our American form of democracy, enough to warrant concentrating our full attention on them?

Out here in the West our own domestic problems take on the same relative measure of increased importance as our national problems.

It is not new, but it is just as true as it ever was, to say water is the lifeblood of the West. All of us are interested, if for no other reason, because we recognize from a purely selfish standpoint that we must conserve and utilize our water resources to the best advantage if our livestock and agricultural interests are to be maintained.

It is a pleasure for me now to pay a sincere compliment to the Bureau of Reclamation of the Interior Department, and to its able Chief, Commissioner John C. Page. The Reclamation Bureau has worked out and is carrying out, with the millions of dollars that we in Congress have willingly appropriated for it, a broad scale program designed to bring about the best use and conservation of our western waters.

If this program is carried to its logical conclusion, through additional congressional appropriations, eventually our farmers and our cattlemen and sheepmen will have some assurance that their operations will be profitable.

I am thinking particularly, and in connection with reclamation, of our great western sugar beet industry. Frequently we hear someone say in derision or despair that this, that, or the other thing is in a state of flux. Right now, my friends, the sugar industry is certainly in that unfortunate condition if any industry ever was.

The West has millions of dollars invested in the sugar beet industry in Montana, Wyoming, Colorado, and our sister States. Our farmers plant thousands of acres in sugar beets. Some of them get their only cash returns from this crop.

Scattered through our western country are factories where the beets are processed and where thousands of men are employed. The millions of dollars into which the sugar beet industry is translated spread themselves through the whole economic life of our section. Our farmers, the beet field workers, the factory employees, the railroads, the merchants, the people who invest in securities of the sugar companies—these all share in our sugar profits.

I know how sugar enriches the life of our western people. In my opinion, and I intend to urge my views when Congress convenes in January, the whole question of sugar legislation should be reexamined and revised so that we can mesh the gears of our sugar beet industry into the vast reclamation and resettlement programs.

We need to go back to Washington in January and work out a sugar bill for the benefit of our farmers.

I have favored, and shall always favor, as long as I have a voice in Congress, the protection of the American market for the American producer.

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[1] Excerpts from an address delivered before the NRA convention at Denver, November 16, 1939.

Land Use, Soil Conservation and Water Facilities

By E. H. WIECKING, *Associate Coordinator of Land Use, U. S. Department of Agriculture*[1]

I MUCH appreciate this opportunity of meeting with you today and of discussing matters of mutual interest. Normally, you would expect me to touch upon the whole sweep of Department of Agriculture activities, and their bearing upon the stability and security of western agriculture. The basic purpose of my Department is to aid those who use the land to achieve stability of income, stability in the use of our basic land resource, low-cost production and distribution, and the widest possible consumption of our abundant production.

To us, wiser use of our water resources is one of the essentials in achieving these objectives. But rather than to attempt a discussion of water utilization in relation to other activities, I shall deal mainly with our interest in water utilization itself.

No one interested in western reclamation can fail to be impressed with the record of the past 6 years. No other period of equal length, I suspect, can show anywhere near comparable results. Most impressive of all, perhaps, is the financial support which the general public has given, primarily through the Federal Government, for construction, refinancing, and rehabilitation. Mr. Hagie's tabulation of Federal funds thus made available tells its own story of the extent to which, on the one hand, the needs of the West for water development, and on the other hand, the values of such development to the Nation as a whole, have received public recognition, especially on the part of those sections of the country whose blessing of a usually ample rainfall has often in the past made it difficult for them to realize how vital water is to civilization—yes, to life itself—in the West.

The Rio Grande Compact is another achievement. The recently enacted repayment statute on your program for discussion represents, I am sure, a significant and necessary adjustment of policy.

New Development Program

Another recent development of much potential significance is the new program, now in its first year of operation, for the construction of water conservation and utility projects in the Northern Great Plains and arid and semiarid areas. Established under a special item of $5,000,000 in this year's Interior Department appropriation act, this program represents an important new line of attack. Since reimbursability is on a different basis, projects not heretofore possible can now be constructed. Relief labor can be utilized in one of the most constructive ways at hand, and for a purpose whose attainment should mean a substantial future reduction in the need for relief itself. These projects will give farm families now on one form or other of public relief a chance to become self-sustaining; help check the drift of destitute, drought-stricken families to the west coast and elsewhere; put water now wasted to good use; and can, if accompanied by other measures, materially aid better land use by relieving pressure on other lands not suited to cultivation that, in the public interest, should be permanently retired from cultivation.

Since Dr. Barrows tomorrow will discuss this new program in detail, it would be inappropriate for me to trespass further on his subject. However, I do want to make this further point, that the Department of Agriculture not only wholeheartedly approves of this program but is in it lock, stock, and barrel, cooperating with the Bureau of Reclamation and W. P. A. in carrying it out. My Department participated in and approved the recommendations of the Northern Plains Committee of the National Resources Committee of which Dr. Barrows is chairman; it joined in recommending to the President that the committee's recommendations be put into effect. My Department has as its responsibilities such things as settlement of the families; farm organization, lay-out, and management; financial assistance to farm families needing such help—and most of them will; technical advice and guidance; and finally, responsibility for administration of the projects upon completion. All of these functions are being fitted into their proper place in a coordinated program through a three-man interdepartmental committee under the chairmanship of the Bureau of Reclamation, where clearly the leadership should be. We all know the job is not easy and that we are going to make mistakes, but as we gain experience and momentum, we feel confident that this cooperative set-up will work and work well. I believe Commissioner Page will bear me out when I say that our men are working together in complete harmony.

It may surprise some of you whose memories go back a bit, as mine does, to learn that the Department of Agriculture is playing on the same team with the Bureau of Reclamation, and with that Bureau as quarterback. Times have changed, and we are glad they have.

This cooperative new reclamation program now has statutory authorization in the Wheeler-Case Act of 1939. It is to be noted, however, that this piece of basic legislation does not embody several features which the National Resources Committee considers essential to the success of the program.

Having gotten onto the subject of how my Department is cooperating with the Department of the Interior, I want to mention three other things.

First, Public, No. 307, passed by the last Congress, which authorizes loans by the Farm Security Administration to be considered as all or a portion of the capital required of settlers on public lands in Federal Reclamation projects. My Department recommended favorable action by the Congress on this bill.

Second, at the request of the Bureau of Reclamation we are now getting ready to cooperate in studying some of the not-too-easy problems of agriculture and land use on the Columbia Basin irrigation project.

Third, in the water facilities program we submit every area proposed for inclusion to Commissioner Page for his review and comment before our own approval is given. To indicate what we do with Commissioner Page's reports—and he transmits the views also of the Office of Indian Affairs and the Division of Grazing—let me cite some examples: (1) We disapproved a project because, although the proponents claimed a good water right, construction would jeopardize the success of an established Reclamation Bureau project; (2) we placed a well-drilling project on a Reclamation Bureau project to provide the water users with needed water for livestock and farmstead use; (3) we limited our installation program for an entire watershed, consisting largely of stock ponds, to an agreed upon total capacity in order to safeguard the water supply for a potential project of the Bureau; (4) we have set up a cooperative planning job in another watershed to work out a coordinated plan under which our small farm facilities will fit into and supplement the program for the larger controlling works.

There need be no conflict whatever between the water facilities program and the Bureau of Reclamation. We are working together, checking with each other, both in Washington and in the field, every day. As we read the report of the President's Great Plains Committee, out of whose recommendations the water facilities program grew, and as we read the great emphasis on achieving better land use contained in the Water Facilities Act itself, we feel that the water facilities program should perhaps not be regarded as a water program, as we are accustomed to think of that term, but as a program for achieving better land use on farms and ranches through providing them with a variety of little facilities, not heretofore available under other Federal authorizations, for improving the farm organization and management, and aiding in the conservation and wiser use of the soil. By little facilities we have in mind such things as stock tanks; wells and equipment for stock, farm gardens, crop production and farmstead use; facilities for recharge of ground-water reservoirs; spring development; water spreaders for getting flood waters onto hay bottoms or pasture lands; repair and rehabilitation of small community structures or provision of a supplemental water supply; or installation of a pumping plant or new community dam for feed or crop production for a small group of farm families. Our appropriation act places a top limit of $50,000 on any project designed in whole or in part for irrigation and the Secretary has applied this to all other funds we use. This in itself looks like a pretty good guarantee that we won't get into the field of activity of the Bureau of Reclamation. As a matter of fact, the great bulk of installations desired by applicant farm families to date have been on individual farms or ranches, and have averaged well under $1,000 each. Our financial aid to community projects has averaged approximately $10,000.

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[1] Address before N. R. A., Denver, November 15, 1939.

In further regard to the water facilities program, let me briefly outline some of the more important elements as we see them:

A. *Legislation and funds.*—You are all familiar with the Water Facilities Act. Two provisions, however, are sometimes overlooked: (a) the requirement that facilities shall be so located as to promote the proper utilization of lands and not be located where they will encourage the cultivation of submarginal lands; (b) the requirement that the Secretary shall not establish any new agency for administration of the act but shall utilize existing agencies and facilities of the Department.

The first appropriation for carrying out the act was made for the fiscal year 1939. We therefore have been on an operations basis for only a little more than a year. For this fiscal year, as for the last, $500,000 was provided under the act. This represents an average for the 17 Western States of $29,000 each.

Last year, however, our total expenditures for water facilities purposes were several times that appropriation. The door is open, for example, to farm families who are not in the low-income group, but financial assistance for them must come from the $500,000 appropriated under the act itself. Subject to that one legal difference on eligibility we have developed a single set of operating policies and procedures which we believe carry out the full intent of the Water Facilities Act regardless of the fact that two sources of funds are involved.

B. *Major current policies of program.*—

1. Coordination with other Federal programs, which I have already discussed, is an established policy.

2. We hold the firm conviction that only through careful advance analysis and program planning for the watershed as a whole, can we make limited water supplies serve equitably and without waste the maximum possible number of farm families; can we comply with the act with respect to promoting wiser land use; can we integrate our work with that of the Bureau of Reclamation, the Army engineers, the State water boards and other agencies whose larger structures necessarily must be controlling; can we supplement the values of these larger developments by providing the beneficiaries thereof with various little farm developments which add to the sum total of benefits received by the farm public through wiser utilization of all the available land and water resources; can we achieve the most economical and efficient use of the public funds.

And finally, we aim to have farm families living in the watershed, as well as the experts, participate in this general planning. And so we work out our watershed programs in consultation with local farmer advisory committees. They contribute valuable advice and criticism out of their wealth of practical experience. The experts are not infallible. And we are sure that when these representative farm citizens have studied a watershed together with the experts, they will have a full realization of both the possibilities and the problems in water development, and of the practices needed for wiser use of their lands and waters. It will be clear that they cannot all have all the wells they want without depleting the ground water supply for everybody, increasing the cost of pumping, or maybe ruining the whole water supply because of salt water coming in, as already too often has happened.

We want the farm people to know and understand what we aim to do—for after all it is their lives, their property, that are affected. A great criticism of Government has been that it is too far away from the people, tending to become unresponsive to their views. Here in this democratic process, we get right down on the ground with them.

Our policy also calls for review of the general watershed plans by a State agricultural advisory council composed of officials of the State land-grant college, representative farmers, and representatives of State agencies having direct responsibility for the administration of land and water resources, such as the State engineer. We want to get their suggestions and criticisms; be sure we are in compliance with State water laws; promote coordination with State policies and programs.

In our watershed examinations and planning, we, of course, try to avoid duplication of the work of other agencies. We use all the technical data we can lay our hands on. But our men are finding that very frequently the scope of such other investigations has not included the problems of soil conservation and these small farm facilities so we are perforce required to undertake additional studies.

3. Facilities will not be installed on public lands except when necessary to benefit adjoining or interspersed privately owned or other non-Federal lands, and then only, of course, with the consent of the agency having jurisdiction.

4. Facilities may be installed, or existing facilities rehabilitated, either for individual use or for joint use of a group of farm operators. For group facilities financial assistance may be made available through instrumentalities such as cooperative associations, mutual water companies, irrigation districts, soil conservation districts, and the like.

5. Beneficiaries are required to make the maximum contribution to the cost of the facility that their circumstances permit, in the way of putting in their own labor, materials, and equipment. The Department will provide the funds, or labor and materials, which are necessary to complete the installation.

6. The amount that the farmer or group will repay the Government depends on their ability to repay. The repayment period depends on the useful life of the facility, but in no case exceeding 20 years, with interest at 3 percent. The repayment schedule is flexible, being adjusted to income flow. The Department does not ask reimbursement for its engineering, soils, farm management, and other technical and administrative services. We believe that education in improved technical practices is an important purpose to be served and should be provided without cost, in line with the long-established educational function of the Department.

We also stand ready to provide without cost, technical assistance in planning for farmers who want only technical aid. Because of limited personnel, we are able to provide this service only in areas where regular operations crews are already at work.

7. Actual construction and installation of facilities can be handled either by having the Department do the job, or making the necessary funds available to the benefiting farmer (or cooperative association or other instrumentality), and having him assume responsibility for getting the job done, including making payments for materials, equipment, etc. In some situations, Department

installation may result in lower costs; in others, installation by the farmers themselves is more economical and expeditious.

8. Tenants as well as landowners may benefit from the program under appropriate safeguards.

9. And finally, we are convinced that the objectives of the Water Facilities Act—to improve farm income and rural living standards through wiser use of land and water—will not be achieved by the mere provision of a dam or a well or some stock ponds alone. There have been too many examples of the failure of the one-line type of approach. Here, for example, is a man or a mutual water company heavily in debt, maybe in default, maybe not yet. Surely something must be done about debts. Have you ever seen that provocative bulletin of the Iowa Agricultural Experiment Station on the relation of debt load to soil conservation? It is awfully hard to put land to conservational use under the driving pressure of heavy debt payments to meet. And so we study the applicant's debt and income situation, bring debtor and creditor together, and see if we can work out a schedule for equitable, orderly payment of debts. Where payment of all debts just is not in the cards, we seek to secure voluntary adjustment. Or maybe the analysis of a man's farm business will show that a water facility will enable him to increase his income through reorganizing his operations to, say, grow more livestock and less grain; and that this shift will make possible putting more of his land in soil-conserving crops. If he needs more livestock, on the basis of this analysis, we will see if we can loan him the money to get some. Or maybe he has been running his water downhill instead of on the contour, resulting in erosion, loss of valuable topsoil, and silting up of ditches and stream channels. Or maybe he has been running too much stock, resulting in soil erosion and depletion of his range. Since a good facility may be rendered ineffective by improper operation and maintenance, this element must be provided for.

Many factors must be considered and coordinated in making successful, conservational agriculture. We try to do this. We call it farm planning. It is a design for better rural living—a combined farm business budget and natural resources budget. And we follow it up with technical advice and guidance for 5 years. Our field men and the beneficiaries work it out together; review it periodically and modify it if necessary. We believe that this is the sort of coordinated service that the public expects the Department to supply—coordinated on the farmer's own farm, and in terms of his own specific problems. We believe that our policy of requiring agreement to follow a 5-year plan is good business, both for the beneficiary and for the Government that is putting up the funds.

C. *Administration.*—After much study, bearing in mind the caution in the Water Facilities Act against setting up new agencies within the Department, we concluded that the objectives of the act would best be achieved by making the program a cooperative one within the Department as well as between the Department and the States and local communities. The Soil Conservation Service has been made the responsible operating agency for the program, and their engineers and soil conservationists have final responsibility for all matters pertaining to engineering and construction, soil and water conservation methods, and leadership in arranging for the preparation of the farm plan that I mentioned. These things are the Soil Conservation Service's regular business.

Departmental Board Formed

The Farm Security Administration has final responsibility for all matters pertaining to financial eligibility, loans, and repayments, and the financial side of the farm plan which it develops jointly, on the ground, with the technicians of the Soil Conservation Service and the beneficiaries. This, too, is the regular business of the Farm Security Administration. For the general, over-all watershed study and planning that I mentioned, the Bureau of Agricultural Economics takes the leadership, with always the full cooperation and participation of technicians of the Soil Conservation Service and Farm Security Administration. This is the Bureau of Agricultural Economics' regular business. To facilitate cooperative action, but especially to hammer out the complex and difficult policy questions that arise, and to see that the Department's policies and programs are in harmony with those of the Bureau of Reclamation and other agencies, a departmental board has been established consisting of a representative of each of these three Department agencies with a member of the secretary's staff serving as chairman. Maybe we are wrong, but we believe that this cooperative set-up is the right approach. No matter how any large organization, public or private, is set up, a job requiring the services of different specialties will require cooperative action.

Now as to accomplishments under the water facilities program measured in wells drilled and concrete poured, I would not be frank with you if I did not say that we are not boasting of our first year's record. But since 1933 I have directly shared the working responsibility for organizing and launching three new Federal action programs, in addition to water facilities, in as many different departments or independent agencies, and have also been in position to observe the initiation of several others. I am bound to say that none could point to an outstanding record the first year. Policies have to be made and revised as experience is gained. Staffs have to be assembled and organized, and some men fired. New fiscal procedures have to be developed. Requirements of the General Accounting Office have to be ascertained. Legal opinions have to be obtained. The public must be made familiar with the program, including its limitations.

The water problem itself is a tough one, as you know, and trying to work out the wise thing to do takes time. In one area, for example, the only technically and economically sound thing to do is build one dam for two communities. Well, it is taking time to get those two communities to agree. In another watershed, to provide a stable water supply for pumping out of the main stream, either one large structure can be built under some program other than water facilities because of the cost, or the plan of several small structures on the tributaries can be adopted. Which is the wiser course, all things considered? Opinions differ—it takes time to arrive at the best answer. Another area is anxious to get a lot of wells drilled—how much withdrawal can that area stand without risking damaging depletion? Can anything practicable be done to recharge the ground water reservoir? It takes time to get that answer. It takes time to organize cooperatives or small districts; it takes time to straighten out the financial structure of others before we can do business with them.

Some of our major policies involve time-taking processes. Watershed planning takes time. So do coordination with the Bureau of Reclamation, cooperation with the local planning committees and the State agricultural advisory committee, checking with the State engineer and other State agencies, and working out a farm plan for the benefiting farmer. As we look down the road, are these and our other operating policies wise ones to build upon, not only for today but also for tomorrow?

Whether or not we are right in our operating policies is to us the important question—and one in which we would welcome your frank suggestions and criticisms—because we feel that the inevitable first year's problems of getting organized and under way are now behind us. We are getting into production. As of November 1, 1939, for example, 62 watersheds comprising nearly 150,000 square miles in area had been authorized for operations; in 116 counties in 15 States, demonstration water facilities were being installed; and in another, 76 watersheds comprising 89,000 square miles had been authorized for watershed planning.

In closing, I should like merely to mention some observations and points of view for consideration:

1. The hope that interest in providing irrigation through storage structures, be they large or small, does not result in overlooking the demonstrated values to agricultural stability through storage in the soil itself by means of improved soil and moisture conservation methods.

2. My belief that henceforth more recognition will be given to the necessity for, and demonstrated values of, putting lands in the drainage basins behind storage structures to

(*Continued on page 16*)

National Resources Planning Board, How It Should Be Constituted

By L. WARD BANNISTER, *Denver, Colo.*[1]

HE ideal planning board or agency.—How a ard should be constituted depends upon its nctions. If it is to cover "human" as well ; natural resources, it would have to be uch larger than if covering only the latter. he human would include education, public ealth, structure of our economy, consumer comes, technological trends, etc., whereas e latter would cover planning for the conrvation and development of our land, water, rests, soil, and minerals.

That there is need of a central planning gency in respect to the natural resources is ear. It would coordinate the planning of e separate Departments of War, Interior, nd Agriculture; would reduce friction among em; avoid duplication; and save expense the Federal Government. The ideal board ould be a statutory board composed of the ecretaries of the departments mentioned or f their chosen representatives, and of a umber of laymen appointed by the President rom widely separated areas of our country, onfirmed by the Senate as fully responsible o the Congress as to the President, and reorting to both on its plans for the conservaion of our natural resources of land, water, oil, forests, and minerals. With all of the olleges and universities, private foundations, nd Government departments to look after he cultural and social development of the Jnited States we may well omit "human" reources as distinguished from natural reources from the jurisdiction of the board or gency except to the extent that the "human" esources relate to unemployment which is a subject so vital that it should fall within the realm of plans for the development of our atural resources.

The three Secretaries should be members of the board because their departments are chiefly responsible for the feasibility, execution, and success of projects authorized by the Congress. The scattered laymen are needed to reflect the needs of the entire country and to constitute a more disinterested body to assist in the decision of the disagreements, if any, among the three Federal departments. Furthermore, their inclination would be to protect the States against undue encroachments by the central Government upon the administration by the States of the waters within their borders. The board should not be under the personal control and direction of the Executive. It should be a statutory board just as open and responsible in all respects to the Congress as to the President in order that our Senators and Representatives, to whom we chiefly look for protection, may have at all times and without embarrassment the information and service they require.

The board we actually have.—The board is composed of three excellent men and possesses an excellent water resources committee. The committee has done valuable work in the different drainage districts of the country, and has been of great service in the West in the adjustment of interstate disputes over interstate streams. The board was created by an Executive order of the President in September 1939 in pursuance of the Reorganization Act of 1939, the Emergency Relief Appropriation of 1935, and the Employment Stabilization Act of 1931. The Executive order, in pursuance of the President's Reorganization Plan No. I, which was presented under the Reorganization Act of 1939 and approved by the Congress, places this National Resources Planning Board under the exclusive personal direction of the President. The jurisdiction of the board extends to planning for the development of the natural resources, to planning for orderly programs of public works, and to the "social, economic, and cultural advancement of the people of the United States." In other words, the planning functions of the board extend to everything in which the people might be interested. For that part of the Executive order which relates to the natural resources, to work programs, and to unemployment as far as connected with the natural resources, there is ample authority in the acts of Congress under which the Executive order was issued. But I find no statutory authority for anything more—no authority to plan for the social, educational, economic, and cultural development of the people of the United States. The Congress evidently had it in mind that education, music lessons, literature, painting, the languages, and general social sciences, all of which are worthy fields of endeavor, would be cared for in some other way.

As the board is now constituted and functioning, it is the exclusive property of the President, although by the Executive order which he has made, its reports will go both to him and to the Congress. That, however, is not enough. This board is going to become, if continued beyond its present expiratory date of June 30, 1940, a great reservoir of information relating to the natural resources of our country and proposed plans for their development. Since all of this information is just as essential to Senators and Representatives and a Congressman should have a legal right to obtain it at any and all times and without embarrassment, the board should be made as responsible to the Congress as to the President. If the board is to become the repository not only for knowledge affecting the natural resources but for all the human resources as well, it is evident that the plan is that it shall become the great planning brain center of the Nation. A brain center is just as much needed in the legislative branch of the Government as in the executive. It is to the legislative branch and not to the executive that the people look for the determination of the laws and policies under which they are to live. It is for the executive branch to carry out the laws and policies which the legislative enacts.

The powers of the present board will expire June 30, 1940. In its connection with the natural resources of the country, it is too important an agency, both from the standpoint of the development of those resources and from that of reduction in Federal expenditures, to be allowed to lapse. It should be recreated and continued but constituted and responsible as I have stated.

Relative powers of State and Federal Governments over the waters of the States.—As a matter of political or law-making power, the Federal Government has no business or authority within the States, whether in the East or West, except where the Congress assumes that authority in a specific instance relating to a navigable stream for the purpose of protecting navigation, and therefore does so under the interstate commerce clause of the Constitution. We of the West have created our own appropriation system of water law. It differs from that of the East. We shall not permit, if we can help it, the extension of Federal control over these waters to tell us how or under what conditions they may be appropriated or for what uses. These things we will determine for ourselves. Decisions of the Supreme Court uphold us in this determination.

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[1] Address delivered before NRA, Denver, November 16, 1939.

Water Conservation Possibilities on the Northern Great Plains

By HARLAN H. BARROWS, *Chairman, Northern Great Plains Committee*[1]

I SHALL comment not only upon the possibilities of water conservation on the northern plains but also upon recent progress in promoting reclamation within the region and upon several other allied subjects. In so doing, I shall draw freely upon a progress report recently submitted to the National Resources Planning Board by the Northern Great Plains Committee. Many of my statements will therefore reflect or quote findings, opinions, or recommendations of that committee, which includes representatives of the Bureau of Reclamation, the Corps of Engineers, the Department of Agriculture, the Works Progress Administration, and the States of North Dakota, South Dakota, Nebraska, Montana, and Wyoming.

Some Basic Facts

In considering any phase of the problem of economic readjustment in the northern plains, it is well to face certain simple but hard facts and their implications. The greatest disadvantage of the plains is lack of sufficient water. Everywhere relatively light, the precipitation is also variable, unreliable, and unpredictable. It prevents or restricts the firm establishment of a humid or even a subhumid type of agriculture. It fluctuates above and below a critical point for crop production, and even a slight decrease in amount from one year to the next may seriously reduce the yields of unirrigated crops. Withering drought, possible in any year, may destroy dry-land crops over wide areas. Agricultural maladjustments to these climatic hazards are basic factors in the chronic adversity and instability prevalent in much of the region. Rehabilitation and stabilization will necessitate such control and development as may be feasible of the water supply afforded by the precarious rainfall and an adjustment of dry-land economy to the exigencies of recurrent drought. Conformity to the ways of nature on the plains must supersede attempts to conquer her. To hope that she may change her ways would be futile. To depend unnecessarily upon palliatives, upon emergency devices that ease without curing, would be detrimental both to regional and to national welfare.

Some recommendations made by the Northern Great Plains Committee in its preliminary report released by the President on October 14, 1938, have been implemented by the Congress and by administrative action. Various Federal, State, and local agencies have worked along other lines to improve conditions on the northern plains. Thus measures to abate wind erosion have been put into operation in recent years on 4,500,000 acres, and trees have been planted on 110,000 acres. Approximately 3,400,000 acres that formerly were cultivated have been seeded to perennial and native grasses and natural reseeding is being facilitated by deferred grazing or by controlled grazing on 17,000,000 acres. With the aid of the United States Department of Agriculture, numerous county committees have made more or less progress in attacking their land-use problems. Many private organizations have worked constructively.

Progress in rehabilitation and stabilization on the northern plains has been made, as the foregoing statements affirm. By and large, however, such progress has been slow. All told, little has been accomplished in most parts of the region toward fundamental, effective readjustments of people to the land in comparison with what needs to be accomplished. There is comparatively little to show in these respects, however much there may be in other respects, for the huge sums spent on the northern plains by the Federal Government in recent years. As the Northern Great Plains Committee consistently has urged, further relief expenditures in the region should promote lasting rehabilitation to the greatest degree practicable.

The Hazard of War

Slow at best, progress in fundamental readjustment might be stopped and much of what has been accomplished might be undone by a prolonged European war. A considerable rise in the price of wheat, accompanied perhaps by a series of generous rains, might tempt the plainsmen again to overcultivate in the hope of speculative gain. Constant vigilance will be needed to safeguard the progress already made and to make further progress possible without interruption. The blunders of the past cannot be retrieved, but they should not be repeated.

Importance and limitations.—Inasmuch as paucity of water is the greatest disadvantage of the northern plains, the effective control and efficient use of the scant supply is a matter of pivotal importance. Irrigation projects should be constructed in the region, as expeditiously as relevant considerations may warrant, wherever it is physically and economically practicable to do so. This is desirable not only because of the superior utility of irrigated land but also because each regularly irrigated acre in the region may make possible the optimum use of 20 to 25 acres of neighboring grazing land through properly integrated farm programs.

The foregoing statements are not intended to lend any support to unsound projects or to imply premature advocacy of untested or inadequately tested projects that later may prove to be meritorious. Importunate proponents of enterprises of uncertain merit would do well to await the findings of adequate technical surveys and economic studies and later to be guided by them. Most of the streams that rise on the plains are as fickle as the rains that feed them. They carry least water in dry years when most water is needed from them. To store their excess water in wet years for later use in dry years would be so expensive that any such proposal calls for careful scrutiny. To extend irrigation unduly in a wet cycle is to invite a shortage of water in the next dry cycle. Probably less than 2 percent, perhaps less than 1 percent, of the total area of the northern plains can ever be irrigated regularly, whether economically or otherwise, from both mountain streams and prairie streams. Wishful thinking can neither increase rainfall nor augment stream flow.

Recommended policy.—In its report released October 14, 1938, the Northern Great Plains Committee stated that it was unable to find opportunities in the northern plains for large or medium sized irrigation enterprizes that could qualify under then existing policy and law. It did find, however, that in some instances the difference between the maximum charges for construction, operation, and maintenance which settlers could reasonably be expected to pay and the total costs involved might be assumed by relief agencies under cooperative arrangements. The committee recommended the adoption of the following policy with respect to such projects.

"(1) That relief funds be expended as practicable and needed for irrigation projects which would reduce the relief load by furnishing a reliable means of livelihood and which would serve as effective units in a proper system of land and water utilization.

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[1] Address delivered before N. R. A. convention in Denver, November 16.

"(2) That expenditures for projects, over and above the reimbursable portions, be limited, insofar as practicable, by the amounts necessary for relief, preferential consideration being given to projects in areas where the greatest amount of relief would be provided.

"(3) That detailed planning of the developmental program be undertaken cooperatively by the various Federal agencies which would participate in construction, settlement, guidance of settlers, and the like, including the Northern Plains Agricultural Advisory Council of the Department of Agriculture and the land-grant colleges, by the planning boards and other appropriate agencies and authorities of the several States of the northern plains region, and by local planning agencies, and that the over-all planning program be coordinated by the National Resources Committee.

"(4) That particular projects be constructed by the Federal agency or agencies best adapted to the work involved, provided, however, that the engineering plans for all relatively large projects be subject to approval by the Bureau of Reclamation and that plans for all projects be subject to certification by the Department of Agriculture with respect to their agricultural soundness and their conformity with an appropriate land-use plan.

"(5) That responsibility for the administration of projects upon completion rest with the Department of Agriculture, and that settlers on the projects be required to repay to the Department of Agriculture the operation, maintenance, construction, land, and other charges to the extent of their ability as determined jointly by the Bureau of Reclamation and the Department of Agriculture, in the light of the productive capacity and utility of the land, the conditions existing on other projects, and other relevant considerations. Repayments for construction, land, and other capital charges, should be made in not more than 40 annual installments. Expenditures from Works Progress Administration funds for these undertakings would be subject, it was assumed, to such provisions with respect to reimbursability as the President might determine.

"(6) That contracts for repayment be negotiated by the Department of Agriculture, preferably with irrigation districts, conservancy districts, or other suitable bodies, and that in selecting projects preference be given, other things being approximately equal, to areas having irrigation, conservancy, or similar districts.

"(7) That the Department of Agriculture assume responsibility for locating on the projects persons in need of resettlement; for buying, reselling, subleasing, and leasing land in order to facilitate construction and settlement (if presently so empowered); for collecting all repayments; and for guiding or advising the settlers in matters of farm practice."

Congressional appropriations.—On June 14, 1938, the President submitted to the Congress a supplemental estimate of appropriation for the fiscal year 1939 for the construction of water conservation and utilization projects in the Great Plains and arid and semiarid areas of the United States, amounting to $5,000,000. Such an appropriation, if supplemented by such Works Progress Administration aid as appeared to be suitable, would have permitted prompt construction of a group of projects recommended by the committee. As may be recalled, the Congress authorized the item of $5,000,000 in the Second Deficiency Appropriation Act, 1938, but provided that the funds were to be taken from funds made available by section 1 of the Emergency Relief Appropriation Act of 1938, and also provided that not to exceed $50,000 could be expended on any one project. The limiting provisions defeated the purpose of the appropriation—insofar as projects recommended by the committee were concerned. It was accordingly recommended by the committee in its report released October 14, 1938, and by the National Reclamation Association in Resolution No. 7 adopted at the Reno Convention, that the sum sought be made available without invalidating restrictions by the Congress at its next session. This was done in the Appropriation Act for the Department of the Interior, 1940.

Selection and construction of projects.—Work looking to the selection and construction of irrigation projects in the program of the Northern Great Plains Committee is proceeding actively and I believe effectively, under the supervision of a subcommittee consisting of representatives of the Bureau of Reclamation, the Department of Agriculture, and the Works Progress Administration, in accordance with the following communication from the President to the Secretary of the Interior, dated June 14, 1939:

"MY DEAR MR. SECRETARY:

"In order to effectuate the purposes of the appropriation of $5,000,000 for water conservation and utility projects in the Interior Department Appropriation Act, 1940, about which you wrote me on May 9, I am requesting that the following procedure be adopted by the interested Federal departments and agencies:

"1. Allocations from the $5,000,000 appropriation will be made for projects individually.

"2. Recommendations for allocations will be prepared by the Department of the Interior in accordance with the general policies set forth in the report of the Northern Great Plains Committee, dated October 14, 1938, and will include the concurrence or view of the Department of Agriculture and the Works Progress Administration.

"3. Each recommendation will include a description of the proposed project, an estimate of the total cost of the completed project, estimates of the work which can be performed by relief labor and of the reimbursable cost, and a statement of the proposed participation of each Federal Agency concerned together with the recommended amounts of funds to be allocated to each.

"4. The Secretary of the Interior acting through the Bureau of Reclamation will be responsible for the construction of projects, except as may be otherwise recommended.

"5. Recommendations will be transmitted to me through the Bureau of the Budget.

"6. The National Resources Committee through its Northern Great Plains Committee will continue to coordinate these and related activities as directed in my memorandum of October 19, 1938.

"I am forwarding copies of this letter to the chairman of the National Resources Committee, the Secretary of Agriculture, and the Administrator of the Works Progress Administration for their information and guidance.

Sincerely yours,
(s) FRANKLIN D. ROOSEVELT.

The Honorable, The SECRETARY OF THE INTERIOR."

Seven projects have been considered by the subcommittee for immediate construction. They are an extension of the first and second divisions of Buffalo Rapids, and the Saco Divide Unit of the Milk River project, all in Montana; the Buford-Trenton and Bismarck projects in North Dakota; the Rapid Valley project in South Dakota; and the Mirage Flats project in Nebraska. The total irrigable area in these projects is about 75,000 acres; the total estimated cost, $11,985,000; the total reimbursable cost, $4,825,000; and the nonreimbursable cost, to be met, it is expected, by work-relief funds, $7,160,000. The Buford-Trenton and Rapid Valley projects and the second unit of the Buffalo Rapids project, have been approved by the President under the procedural program already outlined.

The disparity between the aggregate reimbursable cost and the aggregate nonreimbursable cost of these seven projects is particularly noteworthy because they represent, so far as known, the "cream of the crop" in reclamation possibilities within the region. If they were to be carried out under conditions equitable alike to the Government and to the prospective water users, if, further, they were to form economic havens for a considerable number of distressed dry-land farmers, they had to be developed under some such authorization and policy as recommended by the Northern Great Plains Committee. They had to be treated as relief irrigation projects.

Let the Buford-Trenton project in North Dakota, first of the group to receive Presidential approval, serve as spokesman with respect to the need for rehabilitation and stabilization by any and all practicable means in a more or less representative area of the northernmost plains. In Williams County, within which the project is situated, rainfall has been subnormal in almost every year since 1929. A report of the Bureau of Reclamation completed in 1938 showed that the harvested area had decreased more than 400,000 acres in the 10 years, that the number of horses, cattle, sheep, and hogs had decreased more than 50 percent, that 65 percent of all farms were delinquent in tax payments, and that 15,000 persons out of a total population of 19,000 were supported by direct relief or Federal labor projects.

Investigations have been nearly completed by the Bureau of Reclamation on five projects in Montana and North Dakota that have not yet been considered by the subcommittee of the Northern Great Plains Committee. They are the Marias, Deadman's Basin, Nesson Valley (Right Bank), Cartwright, and Livona Flats projects. Construction of these projects, if found feasible, could be undertaken with little additional preliminary examination. The Bureau of Reclamation has relatively advanced investigations under way in some 10 areas that are thought to be irrigable and the Corps of Engineers has investigations of survey scope that involve combined flood control and irrigation development which are in progress in five drainage areas of the region. Finally, general preliminary studies are under way in several basins tributary to the Missouri River that may develop requirements for the examination of individual areas. Such requirements are not known at present.

Control of project lands.—In its report of October 14, 1938, the Northern Great Plains Committee recommended legislation under which the Department of Agriculture could purchase for later sale or long-term lease land suitable for settlement in the irrigation projects under discussion. It stated the need for such legislation as follows:

"Attention is called by the Department of Agriculture and the Bureau of Reclamation to the fact that unless a substantial proportion of the lands to be benefited by a project are under Federal ownership or control in advance of initiation of the project and as a condition to its approval, the benefits which would accrue from the program to destitute farm families in need of a permanent source of livelihood through relocation will be lost in large measure. Without such ownership or control, landowners within a project could retain for dry-farming or grazing purposes such parts, if any, of their holdings as exceeded in size the units established for irrigation purposes, thus minimizing the population capacity of the project; and speculative, nonresident ownership of irrigated units would be facilitated."

The committee believes now, as formerly, that Federal acquisition and subsequent resale or lease of lands in the proposed irrigation projects of the northern plains are essential to the proper settlement and development of the projects and to protection of the Federal investment in them.

Although it is possible that the item in the Interior Department Appropriation Act, 1940, which appropriates $5,000,000 for water conservation and utility projects conveys sufficient technical authorization for the procedure here advocated, the committee realizes that the original budget estimate was drawn and that subsequent hearings were conducted by the House Committee on Appropriations with the tacit understanding, so far as known, that authorization for federal acquisition and disposal of lands within the projects would be sought through separate congressional action. It is the judgment of the committee that separate and explicit legislation is desirable, even if not necessary.

The Wheeler-Case Act.—Appropriate legislation was needed to permit a continuation of the work of reclamation initiated by the item in the Interior Department Appropriation Act for the fiscal year 1940 that has already been noted. The need was met by an act, S-1802, approved by the President on August 11, 1939, which authorizes the construction of water conservation and utilization projects in the Great Plains and arid and semiarid areas of the United States and the appropriation of such sums of money as may be necessary to carry out the provisions of the act. I shall not discuss the act nor the desirability of supplementary legislation, for the entire subject doubtless will be covered by Congressman Case, the next speaker on the program. I do wish, however, to felicitate Mr. Case upon the passage of the act, to which I trust his name, together with that of Senator Wheeler, may always be attached in the public mind.

Progress under the Water Facilities Act.—The Northern Great Plains Committee has recognized in the Water Facilities Act an instrument of importance for the development of small water facilities as an aid to proper land use in the northern plains. Supplemental irrigation on a small scale and supplies of water for farmsteads and for stock are involved. Progress under the act has been adversely affected by the limitations imposed by available funds, by the difficult problems involved, by limited knowledge of the economies of intermittent supplies of water and of permissible drafts on underground supplies, and by other factors. As a result of initial experiences the Department of Agriculture has made changes in policy and administration which should expedite progress. The rehabilitation of distressed farm families through the installation of water facilities is being expedited by the use of funds provided by the Farm Security Administration. Such expenditures are additional to those made under the Water Facilities Act and further the attainment of objectives sought by the act.

Where Reclamation Is Impossible

Desirable lines of action for rehabilitation and stabilization over the great part of the northern plains which is nonirrigable have been stated in general terms by many investigating agencies. Much ploughland should be returned permanently to grass. Many operating units should be increased in size. Livestock farming, involving a judicious combination of grazing and feed-crop production, should widely replace grain farming. A less unstable income should be sought through diversification of farm programs in some areas, and through growing drought-resistant crops in other areas. Improved relations between owners and tenants and adequate means of financing farm enterprises should be promoted. Town and farm economy should be better integrated. Population density should be adjusted to proper use of the land. The government services of States and counties should be fitted to the readjusted population.

To state abstractly the various problems involved is easy; to formulate concretely practicable means for their solution is difficult. They interlock and together assume an intricate character. They concern Federal, State, and local agencies, most of which have been accustomed to approach them from particular angles along specialized functional lines and without close collaboration. They call for a coordinated approach on a regional basis. Clearly, however, no single pattern of readjusted land use for the region as a whole could provide a sound foundation for a satisfactory economic and social structure, for there is wide variation in the utility of different areas. Intensive studies of representative sample areas are needed.

Such studies, for several of which the Northern Great Plains Committee has provided, may afford a basis for the formulation of programs of readjustment in land use and population distribution in the areas studied. It is probably only by the development of unified and definite programs of readjustment in representative areas that the adoption of realistic policies and procedures in line with the physical facts and economic conditions in the northern plains can be brought about. Successful readjustments in several areas of dissimilar character probably would have widespread influence elsewhere.

Looking Forward

A land of great risks in the past, the Northern Great Plains can become a land of reasonable security in the future. If the change is to occur, constructive action through years along many lines will be needed. If the change is to occur, Federal, State, local, and private agencies and private individuals must work together to bring it about. I trust that the Northern Great Plains Committee may prove increasingly helpful in the joint undertaking. As chairman of the committee I appreciate greatly the support it has received from the National Reclamation Association, and I frankly solicit further support in the following matters:

1. In seeking a suitable appropriation at the next session of the Congress for continuance of the program for the construction of relief irrigation projects.

(*Continued on page 17*)

Candid-camera shots of Bureau of Reclamation officials attending National Reclamation Association Convention in Denver, Colo., November 14–16, 1939

(1) E. O. Larson, K. B. Keener, R. J. Newell
(2) H. A. Parker, George A. Bonnett, E. A. Moritz
(3) L. E. Foster leaves the Conference
(4) William E. Warne, L. R. Fiock
(5) L. N. McClellan, William F. Kubach
(6) J. Stuart McMaster, J. Kennard Cheadle
(7) Walker R. Young and R. S. Calland discuss a Central Valley problem with George A. Bonnett
(8) Donald I. Jerman and William G. Sloan are amused
(9) W. H. Nalder and others listen
(10) H. J. S. Devries tells L. E. Foster and an unidentified gentleman
(11) E. O. Larson (foreground), P. J. Preston (left), and J. R. Alexander (half hidden)
(12) George O. Sanford and S. O. Harper

Improved Methods in Canal Maintenance

By W. H. ROBINSON, *Manager, Gem Irrigation District, Homedale, Idaho*[1]

THE history of irrigation began with an individual diverting water from a small stream on to an adjoining piece of land without having to build canals, and was practiced in Assyria, Babylonia, China, Egypt, and India.

In the United States are found remains of ancient irrigation works in Colorado, Utah, New Mexico, and Arizona, showing that artificial watering was practiced there by prehistoric peoples, some of whose ditches are used in present operations. The Spaniards who invaded the country learned the lesson of irrigation, and carried it back to their kinsmen in Mexico where it was used to some extent. In southern California the early missions surrounded their stations with farms made fruitful by watering the parched plains. About 1850 the Mormons in Utah furnished the United States with the first striking example of practical irrigation on a considerable scale, and about this time, the gold miners in California used some of the water from placer mining operations for irrigating, with enough success to attract attention, and its use was gradually increased.

About 1870 the Union Colony at Greeley, Colo., attained great success, making this district famous. This was really only the beginning, and soon groups cooperated by forming colonies, their settlers locating on small nearby farms and obtaining water from a common source. In this manner, increasing areas were brought under cultivation, and such colonies with individuals, associations, and companies introduced irrigation in many localities.

In the late eighties, millions of dollars were put into such projects speculatively, but few proved profitable for investors, although they were the means of substantial advancement in the extension of irrigation.

The whole scheme, however, has became so vast and of such economic importance that State and National Governments are more and more assuming its responsibilities. The Reclamation Act, which became a law in 1902, marked the beginning of a new era in irrigation in America.

Early Irrigation Projects

The first projects in the United States were crudely built ditches, and the diversions were made of loose rock where handy, or were made of logs, wire netting, and straw, which washed out each spring in the high water, and had to be replaced before the beginning of the irrigation season.

The early systems depended upon the natural flow of the rivers diverted by dams and canals, but in the growing season the streams were lowest, and when water was most needed, it often was not available. This condition resulted in the extensive building of dams and storage reservoirs, in which are collected the flood waters, thus not only insuring a supply when most needed but making possible the greatest use of the stream.

The first canals were constructed by hand labor or by teams and small scrapers called slip-scrapers, taking five or six of them to carry a yard of dirt. Then, later, wheel scrapers, fresnos, and carry-alls of different sizes holding as much as 12 yards to a load were used, which were quite an improvement over the former method. These were used in cleaning and maintaining the canals, while most of the laterals had to be cleaned with hand labor using shovels. Efforts are now being made to build small ditches and V's that will handle this work more economically.

Practically all the structures such as headgates, weirs, checks, and culverts were built of wood, which lasted only a few years and had to be replaced. Now, practically all structures are built of concrete or steel, which reduces maintenance costs. On our project (the Gem Irrigation District of the Owyhee project), which was built in 1912, practically all the structures were built of wood, but most of them have been replaced with concrete or steel. We had about 3 miles of untreated wood stave pipe which was buried, and in a very few years had to be excavated and placed on piers to stop the deterioration. Later, concrete pipe replaced these.

We also had miles of metal flumes built on wooden structures, which are being replaced with concrete syphons. With permanent improvement of the structures, maintenance costs are reduced and service improved.

During the earlier years of operation of our project horses and scrapers were used for cleaning canals, but it became more difficult to get teams and men as the settlers were busy at that time of the year upon their farms. We also found it very difficult with teams to maintain the slopes on the banks of the canals, which was necessary to maintain the full capacity, because the weeds and grass would grow and accumulate silt until the banks were nearly perpendicular.

Later Improved Structures

Projects built during the past decade were constructed with permanent structures, uniform slopes on the banks and roadways on the banks to facilitate the distribution of water. Large savings in maintenance costs have been made where canals were lined with concrete. Although the expense of lining these sections of canal has been rather high, the saving in the loss of water and the maintenance costs have more than paid for the expense where water is expensive. In the past few years several canal lining experiments have been made with asphalt and gravel reinforced with cotton fabric, which is a cheaper method, but is yet in the experimental stage. A section of canal about a mile in length belonging to the North Extension Canal Co. of Soda Springs, Idaho, was lined with a mixture of asphalt and gravel and reinforced with heavy cotton fabric. I am told that the company had a loss varying from 20 to 30 percent before lining this section, whereas after lining the loss was cut to about 1½ percent. The cost of maintenance is greatly reduced, because there is no expense of cleaning and mossing.

The Seventy-sixth Congress appropriated considerable money for the Department of Agriculture, one of the items being for emergency erosion control, which included research and demonstration work on fire control and irrigation construction work to eliminate hazards in the Everglades region of Florida. It would seems that the irrigation districts of the Northwest certainly should get some help from the Department of Agriculture in making experiments on canal linings, using the surplus cotton and asphalt method. If these experiments were made in different localities, it would certainly prove of value, and I would recommend to this Congress the passage of a resolution asking for this aid.

There is also a great advantage in using sodium chlorate, carbon bisulphate, and arsenic in different places on canals, which eliminates the growth of weeds and willows, especially around bridges or structures where one is unable to clean with machinery. One application of these chemicals, which would last for a number of years, greatly reduces the amount of hand labor that otherwise would be necessary to maintain the canals. The wholesale poisoning of gophers, as now practiced by most canal companies, has practically exterminated the rodents in many sections, and has greatly reduced breaks in canals and laterals. This has been done in most instances in conjunction with the Department of Agriculture and the Civilian Conservation Corps. This work has also been of great value to the individual farmers.

About 10 years ago, we purchased a tractor and road grader. We first used these to build roads on top of the banks. At that time, they were not building angle dozers, and if we had had one of them at that time, the work would have been much simpler. We built these roads on the banks during the irrigation season. After the water was turned out of the canals, we built a small vee and attempted to slope the banks and put the dirt on top of the bank, but finding we were short of power to make any progress, we purchased another tractor and built a large vee, using timbers 24 feet long for the wings shod with steel grader blades, using a hinged nose shod with steel and making the wings adjustable for different height banks. One tractor was hitched to the nose of the vee and the other to the end of the wing. This worked very satisfactorily on ditches that were not more than 6 or 7 feet deep, laying the burm upon the bank where it could be reached with a grader and scattered across the roadway.

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[1] Paper read November 14 before NRA convention in Denver.

Next, we purchased a rotary scraper to be used with a tractor for removing silt deposits and repairing breaks or building fills. This replaced the teams, and we found it to be very economical in operation.

Then, a few years ago, we purchased an angle dozer to be used on one of our tractors, which is very useful in repairing breaks and moving dirt on short hauls. It takes the place of a grader in a great many instances, with more economical operation.

The carry-all scraper is another piece of equipment that can be used to very good advantage in removing silt from canals, building up banks, repairing breaks, and numerous other jobs. These are being built in different sizes to be used by the various tractors, and will handle up to 12 yards to a load. Where these can be used to advantage, dirt can be moved as cheaply as by any other method.

The dragline is another piece of equipment that is very useful in the repairing of breaks and moving quantities of dirt where heavy cuts are made, and has been used but comparatively few years for this type of work.

Our next task was to solve the problem of cleaning the ditches during the operating season of moss which grew in the bottom of the ditches during the hot weather, and of grass and weeds that grew on the bank, which went to seed and were distributed over the farms. In the earlier years, the canal banks were mowed with teams and mowers, and the moss was mowed with scythes by men wading up to their waists in water, or by disking or harrowing after the water had been cut down in the canal, which deprived the water users of water for several days each time a canal was cleaned. During the hot weather, this meant considerable loss to the farmers. We conceived the idea of using a heavy chain with a tractor on each bank dragging it lengthwise in the ditch, and after some experimenting, found a combination of railroad iron used in the center and heavy chains fastened to the end of the railroad iron, reaching above the water line on the slopes of the banks and then a cable from the chain to the tractor would practically clean the canal of moss. When spillways were available so that the water could be wasted for a short time, the moss could be diverted through them into a creek, which is much easier than having to install trash racks and pitch this moss out by hand labor. In most instances, when cleaning the canals of moss by this method, it is not necessary to reduce the amount of water in the canal, and if there are not too many obstructions, such as bridges, checks, and fences, a crew is able to clean up to 20 miles in a day.

Another piece of equipment is the self-propelled dredge, using an endless chain with buckets on it to elevate the dirt on to the bank. This is used extensively where large amounts of silt are deposited in the canals from rivers and streams from which they divert.

For a number of years we have been very well satisfied with the tractor equipment being used for the operation of our larger canals, and have been able to maintain the slopes and control the weed growth on the banks, but as considerable difficulty has been experienced in maintaining our smaller laterals, we purchased several manufactured V's of both the single and double-winged type, which have worked very well, although they were hard to adjust to the different sized laterals, being of varying widths and bank heights. Therefore, a year ago we decided to build a double-winged V or ditcher according to our ideas, and obtained an old grader frame, moldboards, and other grader parts from an equipment company. Then, we purchased some truck wheels, bearings, and tires and fabricated a machine in our shop. We, of course, found some weak parts and had to rebuild it, but after making a very few changes, the machine was used for over a month, last fall, and will be used at the end of the irrigation season for general cleaning. This ditcher is controlled by hand wheels, the same as a grader, and will lift high enough to clear the banks when going into and out of a ditch. It is built heavy enough so that an 80- or 90-horsepower caterpillar tractor, or two smaller machines, can be used as power. The amount of power needed is dependent upon the amount of dirt to be moved in shaping up the ditch or lateral. This ditcher is adjustable and can be used on ditches or laterals from 3 to 7 feet wide on the bottom, with a maximum 6-foot bank. It can be used either by hitching directly to the machine and putting the tractor in the bottom of the ditch, or by employing cables and pulling with a tractor from each bank. It holds the width of the ditch uniform, which of course makes an even velocity of water and avoids the depositing of silt which, with ditches wide in one section and narrow in the other, accumulates rapidly. It can also be adjusted so that any desired depth of silt can be removed from the bottom of the ditch and works very well where the ditch is fairly wet, as it will handle sticky material.

By working the bottom of the canals and laterals most of the moss bulbs which discourage the growth of moss during the next season are torn up.

One-Winged Ditcher Does Good Job

Recently, a local man in our community has developed another machine for ditch cleaning, which has great possibilities. It is a one-winged ditcher, directly connected and controlled by a dozer frame and power control from a tractor. This machine, which can be used in canals by one man, takes the place of a back-sloping grader and does a very good job, maintaining the slopes of the canal banks.

Since using power equipment on our canals we have obtained the following results:

First, a saving of about 25 percent in maintenance cost.

Second, by keeping the canals clean of moss and weeds we have been able to deliver the full capacity of the canal a greater percentage of the time.

Third, by mossing with this heavy chain, we find considerable silt is stirred up and the water takes it on through the canal, saving the removal at the end of the season, and we also find that where any leakage occurs, this method tends to seal the leaks and reduce the seepage.

Fourth, by maintaining the slopes and widths of the canals and laterals, the velocity of the water is nearer uniform and considerable seepage and evaporation are eliminated.

Fifth, by maintaining a good roadway on one bank of the canal, a more economical and satisfactory distribution of the water can be made, as the ditch rider and water master are able to cover a greater mileage than was possible when using saddle horses, reducing the number of ditch riders and consequently the cost of operation.

Sixth, by replacing wooden structures with concrete and steel, maintenance costs are greatly reduced.

Seventh, generally, there is very little time after the irrigation season in the fall, or before the irrigation season in the spring, that weather will permit canal work, and it is possible where using machinery, to work several shifts a day by using lights. This feature is also of great advantage in case of breaks during the irrigation season, as equipment can be operated continuously, while teams cannot.

We still use some team and hand labor to clean the small laterals of moss and weeds during the irrigation season, but less work is done by this method each year. Because of the advantages of using power equipment for canal maintenance, I think any canal manager would be greatly handicapped to have to operate under the old methods, after using the new, improved methods of the past several years.

Drainage and Clearing---Desirability and Method

By WILLIAM E. WARNE, *Director of Information, Bureau of Reclamation*[1]

RECLAMATION of lands for agricultural use has taken on a meaning in the United States more restricted than the dictionary definition intended. It has almost come to mean the reclamation of arid lands by irrigation, and this is because the work of the Federal Bureau of Reclamation has been confined to this single field.

Some recently have argued that the Bureau, like the word "reclamation," need not be so confined; that it would be appropriate for the Bureau's work also to encompass the wider range of reclamation of wet lands by drainage and of cut-over lands by clearing.

Strong and, in some respects, convincing cases have been made for reclamation by drainage of wet lands, specifically in the alluvial valleys of the South, and for reclamation by clearing, specifically of some of the cut-over land of the Pacific Northwest.

It might be noted that present appeals for expansion of the Federal Reclamation program in these regards represent a recurrence of interest, especially in the South, rather than the stirring of a new idea. When, after the World War, soldier-settlement programs were being considered, a great deal of study and planning, much of it rather general, was given to drainage and to clearing operations throughout the country. This generated an interest in the South which grew into a very active campaign for inauguration of a reclamation program for the Southern States both by drainage and by clearing. This campaign broke in 1930 when a push for legislation failed at the last moment to reach its goal.

A decade ago in the Pacific Northwest serious proposals for consideration of reclamation by clearing were first brought forward by a group led by C. J. Zintheo of Seattle. The press westward of a new wave of migration during the past few years from the Great Plains and other areas has given added emphasis to the need for such developments in that area.

Even a hasty review of the reports, summaries, and studies available will lead to the conclusion that the need in the Southern States is at least as great for rural communities patterned after those fostered on our Federal Reclamation projects in the West as it is for drained land for expansion. Educators and rural sociologists who in the past have sponsored movements for extension of Federal Reclamation activities to the South have stated two objectives: (1) the addition of good productive land to the southern farming areas, and (2) the establishment there of progressive, general-farming communities in which home owners might operate single-family farms. Strong are the arguments running through these reports against single cropping, against tenantry and attendant social evils and economic perils. It seems apparent that a program for reclamation by drainage which was not planned to establish a comparatively large community of small farmers would be unacceptable to most of the enlightened people of the Southern States.

At this time in 37 States 84,400,000 acres, mostly east of the 100th meridian, are organized in drainage districts. In these districts about 63½ million acres are cultivated. It was estimated in a report by the Land Planning Committee of the National Resources Board in 1934 that about 30 million acres of good land could be drained at an average cost of $30 an acre. Only a part of this land lies in the Southern States. Since 1930 virtually no new districts have been organized.

The Reconstruction Finance Corporation on November 1, 1939, had authorized refinancing loans totaling $38,000,000 to some 300 drainage and levee districts covering upward of 10,000,000 acres. These loans compare with the total investment in drainage and levee districts of $680,000,000. On the same date the Reconstruction Finance Corporation had authorized loans totaling $66,000,000 to privately financed irrigation districts, wholly in the West. These loans compare with a total investment in private irrigation enterprises approximating $780,000,000.

While these records are not conclusive, they might indicate that the drainage enterprises experienced, during the depression, difficulties no greater than those of irrigation enterprises and other farming activities.

One recent report has stated that overproduction of agricultural products indicates that little need exists at present for the drainage of additional lands. Others have urged the colonizing of progressive communities on newly drained land as a means of introducing general farming in the South. These argue that by this means an attack could be made on present practices of planting cotton or tobacco exclusively, thereby reducing reliance on crops of which overproduction has been a constant threat, and also, thereby providing vegetables, milk, and other dietary needs in a section where their production and their consumption are below the national average and, in some areas, below normal health requirements.

Reclamation of Cut-over Land

Turning for a moment to consideration of the possibilities of reclamation by clearing of cut-over lands, one who investigates this subject will be struck at once by the lack of reliable or specific information. It was estimated in 1919 that a total of 176,183,000 acres of cut-over lands existed in the United States, and no accurate later figures are available. Except for some few local studies little has been done to determine the extent of the cut-over lands which are adaptable to agricultural uses. In the West, except in the Pacific Northwest, there is apparently little, if any, cut-over land which would make good farm land. Investigations have shown, however, that along the northern Pacific coast some of this type does exist. The cost of clearing along the Pacific coast is relatively high owing to the size of stumps.

The definition of the term "cut-over lands" is the subject of some controversy. Certain authorities point out that many wooded or forested tracts have once been cleared, and therefore might be considered to be cut-over. The lands referred to in this particular discussion might better be described as "recently cut-over lands." The lack of clarity in the term is cited merely to indicate the inexactness of information on the subject.

About the only definite fact which has been ascertained is that there is some cut-over land in the Pacific Northwest, and probably a considerable amount, which, through clearing, could be made into good farm land. It seems reasonable, also, to assume that through use of heavy machinery or through marketing of byproducts of the clearing process, or both, the reclamation costs could be held to figures which would make a demonstrational clearing program worthy of consideration. Of course, it is obvious that the greater portion of the present cut-over lands in the West should be used in reforestation.

Individuals and small groups are continuously clearing small parcels for farming purposes in the humid coastal regions of Oregon and Washington. Not all of this work is done in areas of good soils, and it lacks general direction. For the most part, this reclamation is done on the initiative of one who spends part of his time at gainful employment nearby and who may take a year of spare time in which to clear an acre. This unplanned and unconcentrated effort does not do full justice to whatever possibilities may exist for reclamation by clearing since little scientific investigation of soils precedes it, since absence of group effort prohibits use of most economical methods, and since it tends to bring into production scattered units which may or may not have satisfactory community connections and market facilities.

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[1] Address delivered at the Eighth Annual Convention, NRA, in Denver, November 16, 1939.

If it should be determined that the need for reclamation projects of the drainage and clearing types warrants action, it seems very clear that the first two steps must be reconnaissance surveys of regions and detailed studies of specific, selected areas in the light of present day conditions. The third step very likely might be the construction of one or more carefully planned demonstrational developments.

A group of proponents of extension of the activities of the Bureau of Reclamation to the Southern States is interested in the use of the Bureau's facilities in rehabilitating existing drainage districts. This group compares the strengthening of levees and reconstruction of drains with the remedial irrigation projects included in the Bureau's present program. The analogy is not completely clear. The remedial irrigation projects are not, as a rule, designed to reconstruct existing irrigation works which have been permitted to deteriorate. They are designed rather to provide supplemental water supplies for developed areas generally with distribution facilities that are in good order.

Suggestions have also been made that the Bureau of Reclamation might render a service by improving irrigation facilities in the rice producing areas of the lower Mississippi Valley, where most of the irrigation in the humid region is concentrated.

The work of the Bureau of Reclamation originally was confined to the 16 western public land States. The theory behind this restriction on the area becomes clear when it is understood that the reclamation revolving fund, which the Reclamation Act of 1902 set up, was to get its working capital from a portion of the proceeds from the sale of public lands. Little public land existed outside these States. Later, however, a seventeenth State, Texas, which was not a public land State, was added by an act of Congress to the list in which the Bureau of Reclamation might operate.

This is brought out because at the recent regular session of the Congress a bill was introduced to extend the reclamation act to three additional States: Mississippi, Louisiana, and Missouri. The purpose was to make it possible for the Bureau to undertake drainage projects in the States along the lower Mississippi River, although it was not so stated in the bill. The Department of the Interior did not make a favorable report. The reasons, apparently, were the status of the reclamation fund and the uncertain status of drainage projects such as those which were contemplated in the reclamation program which has been authorized.

A more direct legislative approach is desirable in any event. A clearer statement of objectives, of the means of financing drainage projects, of the scope of the proposed program, of the authority to be vested in the administrative agency, and of the intentions of the Congress is necessary to the introduction of any such new program if that program is to move forward smoothly.

The clamor for extension of the activities of the Bureau of Reclamation to these new fields presents a problem which should be carefully considered. It clearly is not appropriate for those interested primarily in irrigation to say, "Let those interested in other types of reclamation work out their problem by themselves," because the hopes and aspirations of those bringing forward the new plans are so nearly identical to the objectives of the irrigation program.

This paper is not designed to present the question of extension of the activities of the Bureau of Reclamation to drainage and land clearing projects either in a favorable or an unfavorable light. The purpose, rather, is to call attention in the convention to the growing agitation for such extension.

The Great Plains Program in Congress

By HON. FRANCIS CASE, *Member of Congress from South Dakota*[1]

THE Great Plains have been the forgotten spot in the Nation's soil economy. They were not dry enough to forbid an attempt at farming without water. They were not wet enough to demand drainage. The fertility of the soil and the rich grasses invited settlement. The Government encouraged it.

In normal times settlers took their ups and downs and made their own adjustments, tragic or costly as they might be. The combination, however, of bad times for all kinds of agriculture and a dry cycle of unusual intensity and duration caused a tremendous migration in late years from the Great Plains and attracted national attention. At least one government movie and at least one novel have drawn both praise and curses for their dramatization of this movement.

Be that as it may, the great bulk of the settlers are still in the Great Plains country and they propose to stay. They have their homes, their schools, their churches, and their associations of a lifetime. What we call the Great Plains program is designed to help them where they are.

As related to water conservation, the Great Plains program is the utilization of relief labor and of contributions of material and supplies where possible to make practical water conservation projects not otherwise feasible and bring them within the repayment ability of the water users.

The idea is to get double duty from the relief dollar—help for today and protection for tomorrow. The aim is to stabilize the economic life of the Great Plains by insuring livestock water, winter feed, and human subsistence.

This is not large-scale irrigation. Most of the projects will be small, 3, 5, 7, 10, possibly 20,000 acres in a few instances, all divided among a maximum of individual operators. The projects will be limited by the intermittent character of flash streams. At the most, the water resources people tell us that not more than 1 percent of the Great Plains can be watered, but that much, supplementing an intelligent general land use program, can stabilize the economic life of the short-grass country.

The program is just starting. An initial reimbursable appropriation of $5,000,000 for costs other than labor, and repayable by the water users, was made available in the appropriation bill for the Interior Department, passed last spring. A basic act, designed to put a firm legislative base under the program, was adopted in the closing days of the regular session and approved by the President August 11, 1939.

The program was promptly set up by an interdepartmental committee headed by W. R. Nelson, Chief of the Engineering Division, Bureau of Reclamation, in Washington. Agriculture was represented by Edward G. Arnold, Special Assistant to the Administrator of the Farm Security Administration. Work Projects Administration was represented by Perry Fellows, Assistant to the Chief Engineer. George S. Knapp, Kansas State engineer, and special consultant to the National Resources Committee, served the interdepartmental committee in the same capacity. The committee has proceeded on the recommendations made by the National Resources Committee.

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[1] A résumé of remarks of Mr. Case given November 16, 1939, at NRA convention in Denver.

Projects in Montana and North and South Dakota have been approved for construction, and allotments of funds have been approved by the President. Other projects are being studied. When this association meets next year you will be able to see pictures of actual construction. In the meantime, people will have the immediate benefit of needed work relief and the satisfaction of knowing that their labor is going into a productive enterprise and not merely into a made job.

As the author of the Great Plains bill that was introduced in the House and accepted by Senator Wheeler as a substitute for the text of the bill he introduced in the Senate, and which became the act of August 11, 1939, I can say that the act does not cover the entire problem we are attacking, and needs supplemental legislation, either by amendment or separate enactment. We need a method to finance the purchase of lands within some of the projects for resettlement. Some of the projects do not call for this; some of them do. Possibly existing land purchase legislation can be adapted to meet this situation.

In connection with land adjustment, moreover, we shall need a careful and understanding administration. It must be remembered that the Great Plains settler is about the most rugged individualist still in existence. He is of pioneer stock. He cannot be coerced, driven, or herded. He has battled nature in unkind moods and has a practical slant on things that is extremely valuable. He has been the forgotten man in reclamation conventions of the past. The support your secretary, Mr. Hagie, however, has given the Great Plains program in Congress and the place you have given the subject in this convention are evidence that neither the plainsman nor the Great Plains are to be forgotten in the future.

Land Use

(Continued from page 6)

uses that will reduce destructive siltation of reservoirs, choking of canals and stream channels, and even damage to power machinery and other works. Reforestation, revegetation, measures to prevent overgrazing, erosion control practices on cultivated lands—all have their values, as has now been recognized in the Flood Control Act of 1936.

3. Our conviction that henceforth more consideration needs to and will be given to the multiple-purpose project for flood control, power, navigation, irrigation, municipal water supply, and other uses. It is significant that so much attention is being given to this subject at this meeting.

4. The demonstrated values of land-use treatment in maintaining municipal water supplies, particularly from ground water sources.

5. The hope that our concern for achieving the control of disastrous floods will not result in overlooking the necessity, in connection therewith, of making proper provision for the replenishment and augmentation of vitally needed agricultural ground water supplies whose source in part at least lies in those same flood waters.

6. Continued selective Federal purchase of land submarginal for cultivation. Grand Coulee will provide many needed homes for drought-driven families from the Great Plains. Public acquisition and conservational management of submarginal lands will help those who remain in the Plains to survive by making possible adjustment to a livestock economy better adapted to ride out the recurring dry years than cash grain on quarter or half section units inherited from the homesteading days. I commend to your study the Department's recently published report Land Use Adjustment in the Spring Creek Area, Campbell County, Wyoming. This tells the story of how Federal purchase of only two-fifths of the acreage in this 100,000-acre

area containing much abandoned, deteriorating land made possible the agricultural reorganization of the community into contiguous economic operating grazing units and at the same time brought estimated savings of approximately $1,800 per year in tax money through the elimination of unnecessary locally supported public services.

7. The need for additional State water legislation. In particular, the lack of adequate State laws with respect to the use and control of ground waters is acute. Overdraft and lack of measures for replenishment have already caused some very serious situations, threatening the welfare of large agricultural communities; other bad situations like that are in the making. I am glad that this vital subject is on your program for discussion.

8. Also in the field of State and local effort, I should like at this time to mention four other important lines of action.

(a) Provision for classification of chronically tax delinquent lands, retention by the State or county of these lands thus determined to be not adapted to private ownership, and conservational public management thereof. Montana and South Dakota put constructive legislation of this type on their statute books this year. Also, in some situations, the land assessment and taxation system is a serious obstacle to good land use.

(b) Fuller use of the soil conservation district. Organized under State law, the soil conservation district provides an effective instrumentality, organized and administered throughout in accord with the principles of the democratic process, whereby citizens of a watershed can themselves undertake soil and moisture conservation programs in the community interest, either with or without Federal aid as they choose. As you may know, 15 of the 17 Western States now have State soil conservation districts laws, under which 87 districts have already been organized.

(c) Wider use of rural zoning, another thoroughly democratic measure under which the citizens of counties or similar units of local government may exert some control over land use deemed by them to be in the public interest. Colorado put a rural zoning enabling act on its statute books this year, joining California and Washington among the Western States.

(d) Wider recognition of the merits of the cooperative grazing association, which Montana has pioneered in developing.

The job of better land and water use is so huge a task that all levels of government must participate to get it done. And a very large part of the job—certainly half, if not more—is way beyond the scope of the Federal Government. If it is to be done at all, States and localities must do it. We in the Department of Agriculture believe that in the agricultural field, at least, cooperative land-use planning around the table together between representatives of the Federal Government, of the State governments and agencies, and of the local people themselves will go a long, long way now to show what each level of government can best do, and to coordinate the efforts of all to the common good.

Water Conservation

(*Continued from page 10*)

2. In seeking congressional authorization for the Federal purchase of privately owned land in irrigation projects, with a view to its development and resale or lease.

3. In promoting legislation with respect to Agricultural Adjustment Administration payments for the retirement of certain lands from cultivation under which such lands, if unsuited for cultivation, shall remain permanently retired.

4. In stimulating, in collaboration with other interested agencies and organizations, sound education for conservation and regional planning in the area. "In a Democracy," as the Northern Great Plains Committee affirms, "a workable solution of such problems as those which face the northern plains depends, in the final analysis, upon an enlightened public opinion, and the development of an enlightened public opinion depends upon education—education at all levels and through all channels."

New Water Laws Needed in the West

State Water Law, Water Resources Committee, National Resources Planning Board[1]

AT a meeting of the Water Resources Committee, National Resources Committee, held January 14, 1938, a motion was adopted authorizing the chairman to appoint a subcommittee to draft suggestions concerning a standard water code, giving particular attention to the control of underground waters. The Water Resources Committee, at its meeting July 12, 1938, discussed a request from this association that the committee sponsor the preparation by the interested Federal agencies of a statement of current deficiencies in the water law of Western States, particularly with reference to present Federal legislation. Responsive to the discussion, the chairman appointed the present subcommittee on State water law.[2]

As officially stated in Bulletin R-28, N. R. C., March 31, 1939, the subcommittee was set up for the purpose of studying and evaluating the water laws and constitutional provisions of the 48 States, in order to formulate underlying principles for suggested adoption by the respective States when enacting new water legislation. The 48 States are herein divided into the Western States (comprising the 17 Western States, beginning on the east with the Dakotas, Nebraska, Kansas, Oklahoma and Texas) and the Eastern States (comprising the remaining 31 States).

The subcommittee has held two meetings, the first in Washington, D. C., on January 17-19, 1939, and the second in Berkeley, Calif., on August 21-24, 1939.

At the first meeting Mr. Glick, Assistant Solicitor for the Department of Agriculture, stated that his office had under preparation a report on the law of water rights in the Western States to serve as a reference for the personnel of the Department of Agriculture, especially in the administration of the 1937 Water Facilities Act. The subcommittee decided to use the report as a basis of its study of water laws in the Western States. The study of the water laws of the Eastern States was placed under the direction of Mr. Minard, an attorney, of Newark, N. J.

Prior to the second meeting, Mr. Glick furnished a typewritten copy of the report of his office to each member of the subcommittee. The report is entitled, "Selected Problems in the Law of Water Rights in the West." It was prepared under the supervision of Mr. Glick by Wells A. Hutchins, irrigation economist, who has had about 30 years' experience in this field. The report, when printed, will serve as a comprehensive textbook of outstanding merit. Mr. Hutchins is now engaged, in cooperation with regional officers and water consultants of the Water Resources Committee, in obtaining information from the State and local officials as to the adequacy of present laws and as to possible lines along which readjustment might be made.

Mr. Hutchins discussed his report with the members of the subcommittee at the Berkeley meeting. A novel feature of the report is its extensive treatment of diffused surface waters, a matter which has received but slight attention in texts on water law. It is now a subject of pressing importance in the program of soil conservation. The subcommittee agreed on the legal principle that a landowner should be allowed to use all reasonable methods to cultivate and to conserve his soil.

Water Legislation in Western States

The subject of ground water was given much more attention than any other topic at the Berkeley meeting. Throughout this paper the expressions, "ground water" and "underground water," are used to designate percolating water only. (Water flowing in defined subterranean channels is subject to the same legal rules as is water in surface-water courses.) At the Washington meeting of the subcommittee, representatives of every Federal bureau dealing with water enterprises related their experiences as to water-right legislation in States in which they operated. So far as the subcommittee has been able to ascertain, the general interest throughout the whole country in the subject of ground-water control was responsible for the appointment of the subcommittee. Before considering the legal phase of ground water more fully, I shall digress to present a brief comment on the history of water legislation in the Western States.

So far as its legal aspects are concerned, there are three general classifications of water: (1) Diffused surface water; (2) water in watercourses; and (3) ground water. (A fourth classification, tidewater, is not treated herein.)

As previously stated, diffused surface water has now assumed an importance, not previously accorded it, on account of the activities under the Water Facilities Act.

Water in watercourses has, until recently, been the classification most considered. The common-law doctrine of riparian rights and the western doctrine of prior appropriation received very early treatment by the courts of the Western States. Rules governing the early practices of miners were carried into legislation almost 70 years ago. The first noteworthy improvement on that early legislation was made in Colorado in 1879 and 1881, and in Wyoming in 1886 and 1890. The outstanding figure in the latter improvement was Elwood Mead, who went from the position of assistant engineer of Colorado to that of territorial engineer of Wyoming. He later became the first State engineer of Wyoming. In 1899, Dr. Mead became expert in charge of irrigation investigations of the United States Department of Agriculture. One of the most important duties of that office was the study of water legislation and the publication of reports therein.

The greatest single incentive for the betterment of water legislation in the Western States was the passage of the congressional Reclamation Act of June 17, 1902. It was generally understood that an efficient State control of the water-right situation would hasten the expenditure of Federal funds in irrigation works. Such State control provided for the three essentials: (1) The supervision of the initiation of appropriative water rights; (2) the definition or adjudication of existing water rights; and (3) the distribution of water among those entitled to its use.

As long aso as May 1904, the State engineers of the eight Western States, then having such office formed the Association of State Engineers, for the purpose of exchanging views upon, and the adoption of, improvements in water-right legislation. The present Association of Western State Engineers, organized in 1928, represents all of the Western States. It holds annual meetings for the discussion of topics bearing directly upon the administration of the water codes of the several States. Its last meeting was held here (Denver) on Monday of this week (November 13). Mr. Hutchins then addressed the association on the subject of Ground Water Law in the Western States.

I am placing particular emphasis on the existence and activity of the Association of Western State Engineers as our subcommittee wishes it to be distinctly understood that we think the association knows more about the problems of water rights in the Western States than does any other organization. One of our duties is to attempt to assist it in furthering plans of improvement. It is generally known that some of the Western States have either fallen behind in the movement for better legislation or have made little use of such legislation after its adoption. Each State alone is responsible for the present condition of its water legislation. If that be defective, the reason is not that the State did not have access to very excellent advice on the subject. As indicated above, both Federal and State experts have been ready to assist for at least 40 years.

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[1] Progress report of subcommittee read by A. E. Chandler, chairman, before NRA in Denver, November 15, 1939.

[2] The members of the subcommittee are A. E. Chandler, chairman, San Francisco, Calif.; Frank Adams, Berkeley, Calif.; Philip Glick, Washington, D. C.; A. W. McHendrie, Pueblo, Colo.; Duane E. Minard, Newark, N. J.; and John C. Page, Washington, D. C.

Underground Water Law

The comments just made on the historical development of legislation refer to water in watercourses only. Regarding ground water, three doctrines are now recognized in the Western States: (1) The common-law doctrine of absolute ownership; (2) the "American" doctrine of prior appropriation.

Until 1903 the common-law doctrine of ground water was recognized exclusively in all of the Western States. In that year the Supreme Court of California abrogated that doctrine and set up in its place the "American" doctrine of correlative rights. Under the latter doctrine, each owner of land overlying percolating water is entitled to reasonable use thereof on his land, but he can restrain the taking by an appropriator for distant use only in case such taking will interfere with his reasonable use.

Comparatively recently a few of the Western States have adopted statutes requiring application to the State engineer for the appropriation of ground water. In January 1935, a special committee appointed by the Association of Western State Engineers prepared a "uniform underground water law." The special committee in its letter of transmittal to the association was careful to state:

"This proposed law is not applicable to any State wherein the riparian right to the use of water is in use, such as in California, or to any State wherein correlative rights to underground water prevail, as they do in Kansas."

Entirely aside from the desirability of applying the doctrine of prior appropriation to ground waters, the greatest obstacle to the successful operation of a "uniform underground water law" is the attitude of the courts. In States like California, where the American doctrine of correlative rights has become a well-recognized rule of property, it is my personal opinion that no statute based upon the doctrine of prior appropriation (for ground water) can be upheld.

An interesting case in point is one from Hawaii, which Territory has been included within the field of investigation by the subcommittee. In 1925 a statute was enacted in Hawaii which required application to a commission for permission to bore wells, and empowered the commission to reject applications for cause. After rejection by the commission of an application for permission to bore a well for domestic use on overlying land, the case was taken to the territorial Supreme Court. That court established the rule of correlative rights for the taking of underground waters and declared the 1925 statute invalid. (*City Mill Co. Ltd.* v. *Honolulu Sewer and Water Commission*, 30 Haw. 912.)

Both the Solicitor of the Department of Agriculture and this subcommittee have promised the manager of the Board of Water Supply of Honolulu to attempt to draft a statute governing the taking of ground water which will stand the test of the courts. Judge McHendrie, who has been intimately connected with water litigation and development in Colorado for many years, has been asked by the subcommittee to report to it on ground-water legislation. If a way is found to solve the problem in Hawaii, it should be of general application throughout the United States.

It is now well recognized that statutes prohibiting waste of ground waters will be upheld as a valid exercise of the police power, even in States like California where the doctrine of correlative rights in ground water are so firmly entrenched. The subcommittee undoubtedly will be guided by this established principle in recommending a ground-water statute for adoption in any State recognizing the doctrine of correlative rights in ground waters or that of riparian rights in watercourses.

At its Berkeley meeting, the subcommittee approved an outline prepared by Mr. Minard for the study of water laws in the Eastern States. The study is now being made by Sheldon D. Klein under Mr. Minard's direction.

. The subject of the pollution of water has not been previously mentioned in this paper as a special advisory committee of National Resources Committee has been at work on that subject for many months. It has published at least three reports. This subcommittee will not report upon the topic of pollution, unless it learns of statutes not noted by the special committee, which is most unlikely.

This subcommittee and its assistants are actively at work on the study assigned to it, and hope to report definite results before the close of the present fiscal year.

What the State Ought To Do for Reclamation in Planning and Cooperation

By **CLIFFORD H. STONE**, *Director and Secretary, Colorado Water Conservation Board*[1]

I SHALL treat the subject assigned to me more broadly than the title indicates. In the development and utilization of water which has been termed the Nation's most precious natural resource, the several States are more vitally interested than in merely planning and cooperating with Federal agencies. Such planning and cooperation is without question necessary but in defining the place of the States in this program of development other vital considerations must be noted.

The period of development of water resources through individual financing, which characterized the early day utilization of water from the natural streams, has practically come to an end. This is true for two principal reasons:

First, the remaining opportunities for development are possible only through large expenditures of money necessitating Federal credit and financing.

Second, the public good and a sound national policy demand planning for utilization of the water resources over large basin areas involving in many cases the interests of several States. This is true because the supply of water for essential purposes is limited and the residue must be so used that it will accrue to the maximum economic advancement of the people in the national interest and the industrial welfare of the several States. This means that all uses to which water may be put, as well as the necessities for flood control, must be recognized. Domestic, irrigation, industrial, and recreational values must be preserved to the greatest extent possible. Realizing fully the national phase of the problem, the interest and the part of the States in this development should not be disregarded in the planning and construction of projects. The very nature of the governmental structure, the federation of 48 sovereign States, and the preservation of the principle of democracy make this necessary. Economic development is the concern of each of the States. The ambitions and desires of local areas within the State and the policy of development of natural resources throughout the State must be coordinated with a sound national policy for the development of large areas involving many States.

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[1] Address delivered before NRA, in Denver, November 15, 1939.

State's Responsibility

What is the part of the State in this national problem?

First, the State must as far as possible and on an equitable basis protect and preserve the rights of its citizens in the water resources. It is the claim that this right is founded in the constitutions of many of the States subject to the doctrine, announced by the United States Supreme Court, of equitable apportionment of waters of an interstate stream among the States through which it flows. Weil in his work Water Rights in the Western States (3d ed., pp. 752-755), says:

"Because of its fugitive nature, the only property rights which exist in water in its natural state, under either the riparian rights or the appropriation doctrine, are rights of use, the corpus being susceptible of ownership only while in possession."

Vested rights in water recognized by the laws of the States are founded on the principle of beneficial use and represent large property interests, denial of which would be disastrous to present and continued industrial development. These rights must be reckoned with by the Federal Government and other States. Section 8 of the Reclamation Act of June 17, 1902 (C. 1093, 32 Stat. 388), provides:

"SEC. 8. That nothing in this act shall be construed as affecting or intended to affect or to in any way interfere with the laws of any State or Territory relating to the control, appropriation, use, or distribution of water used in irrigation, or any vested right acquired thereunder, and the Secretary of the Interior, in carrying out the provisions of this act, shall proceed in conformity with such laws, * * *."

The Supreme Court in *California Oregon Power Co.* v. *Beaver Portland Cement Co.*, 295 U. S. 142, holds that the nonnavigable waters on the public domain become "publici juris, subject to the plenary control" of the States, in language as follows:

"What we hold is that following the act of 1877, if not before, all nonnavigable waters then a part of the public domain became publici juris, subject to the plenary control of the designated States * * * with the right in each to determine for itself to what extent the rule of appropriation or the common-law rule in respect of riparian rights should obtain."

The right to control the distribution of water among the water users within the State, without interference from the Federal Government or other States, cannot be surrendered without disastrously affecting existing vested rights and seriously imperiling future development. However, in making this statement it should be kept in mind that States must recognize that they are limited to their equitable apportionment of the waters of interstate streams and large-scale developments, and the appropriation of water for them can in the future be made only on the basis of recognizing coordinated planning over large areas in the interest of the public good. States, with full knowledge of their water resources, should attempt to amicably adjust differences existing between States and Government agencies constructing projects in other States of a river basin.

Second, no State can intelligently and in the interest of the greatest public good promote the development of its water resources without an adequate study of them. This is fundamental and yet in the past has been woefully disregarded. Maximum benefits for the ultimate greatest good of the people of a State cannot in the end be realized without extensive investigations and the compilation of necessary factual information.

As a rule, Federal agencies do not seek projects. In the past they have been in most cases built because of local pressure. In the future this local pressure should be so controlled and so coordinated with large area plans within a basin consistent with maximum development possibilities within the State by State agencies that Federal expenditures of money can be made on a fundamentally sound basis. In many States a realization of this problem has caused the formation of water conservation boards charged with providing the State with a study and formulation of a plan for sensible water development. These boards also are charged with the development of a policy in this regard and with the submission of the plans to Federal agencies. Typical of the powers of many State boards are some of the provisions of the act creating the Colorado Water Conservation Board which with respect to its powers state among other things:

"(c) To devise and formulate methods, means, and plans for bringing about the greater utilization of the waters of the State and the prevention of flood damages therefrom;

"(d) To gather data and information looking toward the greater utilization of the waters of the State and the prevention of floods and for this purpose to make investigations and surveys;

"(e) To cooperate with the United States and the agencies thereof, and with other States for the purpose of bringing about the greater utilization of the waters of the State of Colorado and the prevention of flood damages."

As indicated by the above provisions of the powers of a State conservation board, it should be noted that the greatest possible utilization of the waters of a State is an ultimate goal. This can be accomplished only through a central State agency. If individual States fail to have a plan and are not actively promoting a construction program based upon such a plan, then more forward looking people in adjoining States will ultimately acquire the disproportionate benefits of the limited water resources. As has been said, the development within the State should be coordinated, as far as possible, with basin plans, but if a State is not actively functioning through proper agencies, the needs of its orderly industrial growth may be disregarded.

Third, the States can and should adjust all conflicting interests and claims within a State for project development. In other words water conservation boards have a very important task to perform in perfecting a State-wide program of development. In nearly all States, in some more than others, this requires adjustment of differences between different sections. This should mean orderly development and provide for an equitable distribution of projects throughout the State based upon the principle of the greatest public good and protection of recognized inherent possibilities of development. The laws of the States creating conservation boards should be adopted in such form that no project be recognized unless it has the approval of such a board. If a Federal enactment is necessary to effect this purpose, then effort should be made to secure such a law. This would not prevent a comprehensive plan of development within a large river basin involving many States being worked out by the Federal Government nor deny the greatest possible utilization within a State. Haphazard and unrelated project planning through local pressure and political influence is not conducive to either proper State development or a sound national policy.

Fourth, an informed and properly organized board representing the divergent interests of a State can and should be of material help in coordinating within the State the activities of various governmental agencies engaged in planning and developing water utilization. Integration of various Federal activities is obviously necessary and in a large measure is a question of national policy. However, the States have an interest in this policy. In recent years water interests within the States, desiring to secure maximum benefits to the greatest number of people have become somewhat bewildered because of overlapping Government activities in this matter of water development and are hopeful that a sound policy may be formulated which will not only control planning but actual construction of projects. Conflicting surveys and investigations often delay development. In an integrated plan it is only reasonable and it would seem necessary that the appropriate agencies of the States be consulted and their opinions be considered in the adoption of final plans. This means, of course, full and an enlightened cooperation on the part of the appropriate State agencies.

Fifth, States should foster and encourage the formation, under appropriate laws, of the necessary public bodies such as irrigation districts, conservation districts, and other agencies for the consideration and utilization of water resources. Proper laws should be passed that such State agencies, under the guidance and with the help of a State board, cooperate with the Federal agencies in the making of preliminary surveys respecting the engineering and economic feasibility of proposed water conservation or flood control projects designed for the bringing about of the greatest utilization of the water of the State. They should study, formulate, and prepare necessary legislation to assist in securing the most economical and beneficial utilization of water resources.

Sixth, the States should cooperate and assist in bringing about a policy of improved land-use methods and agricultural practices involving among other things the efficient and economical use of water. Much can be done in this direction in all of the States. This phase of reclamation identified with both the land and water under existing projects needs much attention in the future. An average American farmer is an individualist and does not readily embrace the prospects of extensive Federal control and regulations, but if he is to avoid these regulations he must help solve the problem of preserving land and water resources through the help of his local State government. A well balanced Federal and State policy is necessary.

The development of the water resources is fraught with such wide national significance and at the same time is so intimately associated with the welfare of local interests that it is at once a national and a local problem. In the arid States it is a component part of land use and as stated by the water committee of the National Resources Planning Board, "water problems merge into land problems and both water problems and land problems merge into human problems." Under our form of government human and land problems are the concern of both the Federal and State Governments. It is patent, therefore, that the State has a very definite part as well as an obligation in the reclamation program.

Methods of Noxious Weed Control

By C. L. CORKINS, *State Entomologist, Powell, Wyo.*

THE State and county governments in Wyoming have interested themselves in a financial way in noxious weed control for the past 7 years by assuming two-thirds of the cost of the program. Therefore we as public officials, together with the farmers, have had a lively interest in results and a critical outlook on methods. The program was initiated with practically no background of research or experience in our own State and a conglomerate of rather confusing information from outside. So we placed our faith in selected high-type farmer groups in each county as administrators and practical inspectors with a farming background, as executives of the program coordinated by an entomologist rather than a botanist who knew little of weed-control methods outside of a practical knowledge of policies and procedures which would work on large-scale pest-control projects.

It shall also be my purpose to point out the weaknesses, as well as the virtues, of certain methods which are currently recommended in order that you may avoid some of the pitfalls which we have experienced. And at this time let me warn that methods cannot be transplanted step by step from one locality to another or from one weed specie to another with an expectancy of similar results. Weeds are largely creatures of their environment and to expect that the relatively cheap and simple methods of bindweed control in Kansas, where this weed exists perilously on the outer fringe of its ecological range, will work equally well under western irrigated agriculture, where it finds the highest expression of its development, is utter folly. It is our opinion that these noxious weeds are the most difficult to control or eradicate on our irrigation projects in arid or semiarid mountain valleys where the soil tends toward the heavy and deep clay type, such as the Big Horn basin of Wyoming. Generally speaking, methods which produce results in these areas should, at least in modified form, work equally as well elsewhere.

Methods of noxious weed control may broadly be classified into the two categories of cultural and chemical. Cultural methods are primarily directed at carbohydrate (starch and sugar) starvation in the root system, as this food can only be obtained from the green leaves. Chemical methods are largely root poisons.

The cultural methods which we use include the following, in the order of their present relative importance in the Wyoming program:

1. Continuous alternate deep plowing and cultivation.
2. Continuous deep plowing.
3. Competitive crops or permanent meadows.
4. Alternate continuous culture and winter smother crop.
5. Continuous deep digging.

Continuous alternate deep plowing and cultivation is our standard method. This process is begun in the spring at the prebudding or budding stage of the plants, when the carbohydrate reserves in the root system are at the lowest point in the annual cycle, by plowing to a depth of 8 to 10 inches. This is followed by cultivation at a depth of 5 to 6 inches at intervals of 10 to 18 days for the balance of the summer season. The average number of cultivations the first season is 7. Black fallow is no longer practiced, for our field testing of delayed cultivation indicated that it was safe to allow regrowth on bindweed and Russian Knapweed up to 5 or 6 days and White Top and Canada Thistle up to 8 or 9 days. The last practice in the fall, during September or early October, is a plowing to a minimum depth of 12 inches. If the ground is dry, it is advisable to give a heavy irrigation before it is laid by for the winter, as root decay and break-down is hastened in the presence of heavy soil moisture, and the winter is the most important of all periods of root deterioration.

The second season is usually started with cultivation, followed by the deep plowing in midseason. This midsummer deep plowing will complete a large percentage of the plots, but cultivation is continued on the more stubborn ones, followed by the fall deep plowing.

We seem to be in sharp disagreement with many other States on depth of cultivation, as we generally practice deep tillage and make much use of deep plowing. Perhaps our conditions are different from most. But after trial of both shallow and deep tillage, our County Pest Control Commissioners and Inspectors are unanimous in their opinions that the results of deep cultivation and plowing justify the greater expense of each individual operation. At least on one point we are definitely certain, and that is the great value of a deep plowing as the final operation. This is of such importance that the reasons thereof should be pointed out. In the first place, under cultivation practices, the break-down of the weed root system starts at their lower depths in the soil and progresses upward. The last to drop to the minimum carbohydrate requirement of about 1 percent is the root mass surrounding the first cross-root system in the upper 10 to 14 inches of soil. Particularly at the point, and just below the point, where the roots have been repeatedly severed by cultivation, there is a marked tendency to thicken and produce enlargements which are stubborn in their resistence to decay and persistent in sending up new growth. Plowing at a depth of 12 to 14 inches turns this last stronghold of the root system bottom side up, usually to die by desiccation under a semiarid winter climate or else to succumb to spring and summer tillage of the subsequent row crop. Any live roots remaining below the plow sole are ordinarily too weak to push up through 12 to 14 inches of soil and reestablish themselves.

A note of warning should be sounded on expectancy of results from continuous cultivation, especially under irrigation. There has been much recent publicity flowing from the prairie States farm papers and weed control organizations which makes this problem sound easy, cheap, and that equal results may be expected under all conditions. Our inspectors have long since learned the folly of telling a farmer that if so and so is done to his noxious weed patch that such and such will be the results by a given date. So it may be worth while to enumerate some of the more important factors which affect the time required to kill weeds by cultivation, and therefor the cost. These are:

1. *The weed specie.*—Bindweed is the most persistent specie. Under North Platte Valley conditions, 3 years of cultivation are generally required with 10 to 15 percent going into the fourth year. A large percentage of the Russian Knapweed areas require a partial third-year cultivation. One is usually safe in predicting that the narrow leaf variety of White Top will require only 2 years, but most of the broad leaf variety will require 3 years. Canada Thistle is usually the easiest to eradicate, taking only a year and a half on the average and a small percentage is completed in 1 year.

2. *Age of the infestation.*—Generally, the older the infestation, the longer will be the time required to eradicate it. Some exceptions seem to be indicated on especially old patches which may have been weakened by self-toxicity or reduction of soil fertility.

3. *Depth of soil to sterility or water table.*—Shallow soils or high water tables speed results.

4. *Physical character of the soil.*—Under cultural practices eradication generally is swifter on the heavier, tighter soils. We suspicion that the water-holding capacity is the most important factor here involved. At least, dry and well-aerated soils result in persistent weed regrowth.

5. *Soil fertility.*—A common and disastrous cultural error committed both by farmers and inexperienced weed inspectors is in the lay-out of the area to be cultivated. The most serious fault in this connection is an attempt to individually cultivate out numerous small patches in a field where the weed growth is most obvious. Before the job is completed weeds start showing up between the cultivated patches, and the whole procedure is disorganized. For the most part it pays to break out weed areas in solid blocks. During the process of the work, only the persistent patches need be cultivated every time. There is often also a tendency to "scotch" the size of the lay-out. Plots should be laid out during the peak of the growing season during the summer prior to the spring when the operation is to be initiated. Every straggling plant on the periphery of the weed area should be hunted out with great diligence and the stake line set down at least 12 feet beyond the last one. This seems like commonplace and trifling advice, but I will wager that there are at least a few of you who at some future date will wish that they had paid more heed to it.

Follow-up Program

The follow crop after cultivation is completed is important. Seldom is the job so perfect that a few straggling plants will not reappear. Furthermore, there is often a seedling problem for 1 to 3 years, especially with bindweed. As a consequence, we insist upon the planting of a row crop for at least 2 years, so that straggling plants may be easily located and spotted out with a tablespoonful of dry chlorate or a shot of carbon bisulphide and seedlings killed by the usual processes of cultivation and weeding. If there is a serious seedling problem, deep fall plowing should be practiced every year until it disappears. Sugar beets, corn, and tame sunflowers are the preferred row crops, both because they do better than others on heavily fallowed soil and because any return growth of weeds can more readily be located in them. Following the tillage used to destroy the weeds, the production of these row crops usually steps up from 25 to 50 percent, due both to the improved physical nature of the soil and an increase in nitrates. In case the soil in the weed area is heavy with minerals, alkali-susceptible crops, particularly beans, should not be used as the follow crop because the continuous cultivation tends to increase the alkali problem, temporarily.

A word about cultural equipment, which is a potentially dangerous subject of discussion. For cultivation we have largely used two overlapping gangs of 12-inch sweeps mounted on the deep tiller type of frame. After extensive field trial, it was determined that no deep tiller on the market is properly constructed to fit all the exacting requirements of this job. The present model of Oliver Deep Tiller comes nearest to it, as does the Oliver Fallovator for slow or shallow cultivation, where a stiff spring trip shank may be used. Consequently, we have constructed a deep tiller of local design, the only difficulty of which is the high cost due to custom building. These machines with an 8- to 9-foot cut require a tractor of at least 30 horsepower on the draw bar to pull them at maximum usable field speeds of 4 to 5 miles per hour.

Currently we are testing tractor-mounted tools on a lighter tractor of 17 to 19 horsepower carrying dual rear wheels. After one season's experience we believe this is the ideal set-up for the cultivation practice. No standard make tractor-attached cultivator is available which is satisfactory for the heavy or rocky types of soil, but a locally built unit which works comparatively well is available at a reasonable cost. This whole unit is about 35 percent cheaper than the heavier equipment and will do nearly as much work per hour.

Repeated attempts have been made to improve upon the multiple sweep set-up. The nearest successful approach has been a solid V blade, constructed of ½-inch grader blade steel, 4 inches wide and set on a ½-inch shank. The V is constructed of 2 pieces 5½ feet in length, angled to produce an 8-foot cut. This is mounted on a standard deep tiller with three heavy shanks, one at the point of the V and one half-way out on either wing. The advantages of this tool over the duck-foot arrangement are a 25-percent reduction in initial and upkeep cost, a 30- to 40-percent reduction in draw bar pull and a more positive cutting surface. It cannot, of course, be used in ground filled with large boulders. The greatest weakness, however, is a tendency to tilt in the ground, which problem now seems pretty largely solved. This tool has successfully cultivated at a depth of 12 inches in soil which had previously been plowed to this depth, and is being used to replace some of the previous and more expensive plowing operations.

For power on the plowing job, the 22- to 25-horsepower crawler type of tractor is the standard equipment. These machines are slightly underpowered for plowing a 32-inch cut at 12 inches depth in heavy soil, but the larger crawlers are too expensive and less adaptable to other work on the program. Only two plows seem to be in any way adapted to this tough assignment, namely, the Minneapolis-Moline Tumble Bug and the Case Power Lift. In both instances, the two 16-inch bottom, two-way models are used. Both have to be remodeled to handle this work efficiently, specifications for which will be furnished any interested parties.

The cost factors of this type of cultural practice are important. Of course they vary greatly because of the many variable factors involved, but some idea of the average cost can be given for each individual and each season's operation. The average private farmer is inclined to feel that he can lower our cost factors. Our program is conducted by a public agency and all of the expense of district administration, as well as depreciation, upkeep, labor, fuel, and oil, and incidental expense must be figured in. Thus, our plowing operation costs about $2.50 to $3.50 per acre and cultivation 75 cents to $1 per acre per treatment. The season's cost in the lowest county this year was $9.73 per acre and $18.15 per acre in the highest. The cost in the high county with administrative expense deducted was $11.52 per acre, which is pretty close to a fair average for the State.

Other methods of cultural control can be passed more rapidly, as they are largely variations of the standard method.

Continuous deep plowing has real merit as a practice for the individual farmer who has comparatively small acreages of noxious weeds because it requires the use of only one simple tool which is a part of all farm equipment. If plowed 8 to 10 inches deep four to five times the first year and three to four times subsequent years, this will nearly take the place of alternate deep plowing and cultivation. Of course it is imperative that a clean cut, smooth job of plowing be done. A ragged job is almost worse than none at all. We encourage this plowing practice where the farmer is doing his own weed control work as a qualifying condition for A.C.P. payments.

Weed-Competing Crops

The use of competitive crops in the form of permanent meadows or pastures is largely confined to areas of low-unit land value, such as obtain in the higher elevations of the southern section of Wyoming. It simply controls, but does not eradicate, noxious weeds. At least weed spread is reduced to a minimum and such noxious weeds as White Top and Canada Thistle may gradually be whipped out if the meadows are given proper care. This practice is not so successful with bindweed and Russian Knapweed.

We approach this problem via two routes, (1) Meadow improvement and (2) Initial meadow establishment. On meadow-improvement work, the present sod is left undisturbed as much as possible. The leveling of any rough places in the field is first necessary, so that it can all be watered evenly. High spots, which are unfavorable for meadow grasses, are the first places noxious weeds gain the upper hand. Where necessary, rock picking is an important operation, so that the field may be cleanly cut when mowed. Permanent laterals in the field are smoothed up, made wide and shallow, and their banks evenly contoured outward so that they may be cleanly mowed over with the rest of the field. The only cultural practice is the scarification of the field by means of bull tongues or a power spring tooth harrow as early in the spring as possible, followed immediately by the broadcasting of the seed. The field is kept as wet as possible the balance of the season. This practice is showing much promise in the Bridger Valley section of Uinta County, where the average expense of such has been $4.66 per acre and the biggest job of which has been rock picking. The average rate of seeding has been 15 to 20 pounds per acre of a mixture of timothy, red top, alsike clover, and orchard grass in a ratio of 6–8–8–3.

Initial meadow establishment is preceded by one full season of weed weakening cultural practices, consisting of a spring plowing, three or four summer cultivations and a 12-inch plowing as late in the fall as possible. The seed bed is worked down at the earliest possible date in the spring. Oats are added to the seed mixture as a nurse crop and yellow sweetclover as a quick establishing, competitive, shading crop, which will later be replaced by the more persistent grasses.

The altogether too-neglected method of alternate cultivation and winter smother crops is beginning to gain in popularity in Wyoming. Although this method does tend to drag out the eradication process, it has the decided advantage of producing cash returns as you eradicate. This process is started the same as in the establishment of a new meadow, except the fall plowing is given by September 1, the seed bed immediately worked down and winter rye planted. On heavy soil, the V blade run at a 12-inch depth is more satisfactory than plowing, as it reduces the seed bed preparation job to a very simple process of packing.

This process is repeated the second year. The procedure the third year depends upon the condition of the weeds. If greatly weakened, row crops may be planted for 2 to 3 years, always preceded by a deep fall plowing. If the weeds are still persistent, either winter rye may be continued or a summer smother crop of white sweetclover planted.

A typical first year result of this practice on a 43-acre field of bindweed at Wheatland, 35 acres of which was entirely out of crop production due to the heavy weed growth, may be summarized by the following figures:

1. Cost per acre of all practices, including planting and growing of crop, $13.93.
2. Value of crop per acre, $15.05.
3. Net profit per acre, $1.12.

In casting about for some practical method of using CCC boys assigned to work on the Shoshone Federal Reclamation project, without involving local agencies too deeply in expense and still qualifying under the stringent regulations of the service, which limit the use of CCC facilities to certain types of work on Federal land, we settled upon the simple process of digging the weeds every 2 weeks as deep as possible with a common irrigation shovel. From 50 to 75 boys have been at this project now for 2 years on district rights-of-way, and although the unit cost is naturally very high, the results are equally as good as continuous cultivation and all parties concerned are well pleased.

Use of Chemicals

The two most common methods of chemical control, carbon bisulphide soil fumigation and temporary soil sterility by the use of sodium chlorate, will be quickly passed with a few brief comments, both because knowledge of them is common and because we become less favorably impressed with their use every year.

Carbon bisulphide would be the ideal herbicide if its cost were not prohibitive, its effectiveness limited to medium and sandy-loam soil types, and the use of experienced crews necessary in its application.

Sodium chlorate is a disappointing herbicide, especially in a combination of arid climate, heavy soils, and White Top. Our experience indicates that the action of this chemical is more important as a soil sterilant than as a tissue poison to be translocated from the leaves by circulation or wicking to the root system. Hence we apply it to comparatively barren ground. The most important factor in its successful use is its rapid penetration to the depths of the root system in water solution. This we apply during the fall to get the benefit of both winter and spring natural moisture. There seems to be little difference between wet and dry applications, except that the dry application may be ruined by wind erosion before it starts into the ground or washed unevenly over sloping surfaces by rapid precipitation.

We commonly use dosages of 8 to 10 pounds per square rod, which makes the initial cost $175 to $200 per acre. But on the heavier soils, under an average annual precipitation of less than 10 inches, the chlorate method is practically hopeless, especially on White Top, as another $200 to $300 per acre will have to be spent on follow-up treatments during subsequent years, often with the job never quite completed on some areas. The great difficulty with the chlorate treatment is that it kills the root system from the top of the soil downward as it gradually penetrates the soil. The first year or two, it may appear that a reasonably good result has been obtained. Then a few straggling plants start emerging from the lower root system and if the plot is neglected, it gradually becomes reestablished with plants which will now be found to be highly resistant to further chlorate poisoning.

The results on chlorate treated areas inside of fields, after lying untouched for 1 year, will be greatly enhanced by common farm tillage practices. However, on irrigated farms, these areas often become flooded with water during their first year, and the chlorate washed out before it is fully effective.

Continuous Burning

In our desperation, we started casting about 3 years ago for some cheaper and more positive method to replace these chemicals, and, out of our testing, settled upon continuous burning as possessing the greatest possibilities and subsequently put it into actual field practice this spring on 18 acres of weeds, largely White Top, composed of 889 patches over a 101-mile route at Powell, handled by 1-power burning rig manned by a crew of 2. It is yet too soon to draw final conclusions from this experience, but we wish to briefly report it here in order to encourage others to give it further trial under other conditions.

The most important factor in the burning process is to lightly sear the plants, rather then heavily scorch or completely consume them. The flame should be passed rapidly over the upper surfaces of the foliage so that it is seared so lightly that the plant will not entirely wilt down until the next day. Tight burning is like a clean cut at the surface of the ground. The plant springs up into life again almost immediately. Light searing kills the plant several inches down into the root system, by what physiological process we do not yet know.

When the test work was started, a tight burn was used. This necessitated reburning every 10 to 14 days. With the light searing, the intervals between burning lengthen out to 3 to 5 weeks. The first application is made on heavy spring foliage at the prebudding stage. Subsequent applications are made when the small foliage plants, such as White Top, regrow to a height of 3 to 4 inches, and larger plants, such as Russian Knapweed, regrow to a height of 6 or 7 inches. It is important to always have a fair amount of foliage to sear.

This method seems to work best on White Top and Canada Thistle, which, on the average, will be eradicated with 8 or 9 burnings, 5 the first and 3 or 4 the second year. Bindweed and Russian Knapweed seem more persistent under this method and it is not yet certain that it can be applied to them at an economical cost.

Since this method has been put into the field on large-scale operations for only 1 year, results and cost factors are still a bit theoretical, as they must be partially based on experience with the completed test plots. In the field work this year, 8 patches needed only 3 burnings, 13 required 4 burnings, and the balance 5 burnings. Forty-three patches show complete eradication in 1 year, 267 are more than 90 percent killed and the remainder show definite signs of weakening. On these first-year results, and in the light of our experience with the test plots, it is safe to conclude that the total cost factors will not quite be doubled for the 1940 operations. The average cost per acre for 1939 has been $87.10. This is broken down to 47 percent for labor, 22 percent for burning oil, 17 percent for machine costs, and 14 percent for administration and miscellaneous.

This points out one of the advantages of the burning process over herbicides, namely, that it keeps most of our money at home. But a far greater advantage is the fact that burning results can be read from the surface of the ground. When plants no longer reappear, the lower root system is dead and there is not the problem of delayed regrowth, as is the case with the chlorate method. Furthermore, the value of each burning application cannot be thwarted either by untoward acts of nature or man and the soil is immediately productive following the completion of the eradication process.

Our burning method is a bit unique. The use of generator types of burners was eliminated because they are both dangerous and slow. So we have developed a method of burning highly atomized low-grade fuel under pressure by igniting it at the outlet nozzle. The common fuel is refinery refuse with the flash point slightly raised by the addition of 10 percent distillate. On the average, this fuel costs about 2 cents per gallon. Furnace oil, which costs 4 cents per gallon, also makes an ideal fuel, and is little more expensive than the refuse, because less is used per treated unit.

The fuel is put under pressure in a power spray rig, run out through high pressure hose to a 12-foot, ¼-inch-diameter iron pipe flame thrower, controlled by a Chipman weed gun cutoff. This pipe is constructed with a 10-inch complete loop at the end, to which the nozzle is attached, directed at a slight angle under the loop. Thus the flame from the nozzle plays underneath the loop, and preheats the oil in about 30 inches of ¼-inch pipe before being released. The disk used in the nozzle has a 3/64-inch outlet, and is grooved so that a flat, fan flame, rather than the usual cone, is produced. For the refuse oil, 100–125-pound pressure is required, depending upon the grade. Only 75-pound pressure is needed for the furnace oil.

The individual farmer can make a satisfactory hand-burning rig by mounting a lever-action orchard pump on a steel barrel at a cost of $15 to $20.

Long-felt Need Met by New Publication on Farm Irrigation

A LONG-FELT need for up-to-date information on irrigation farming is expected to be met by the Farmer's Irrigation Guide, Conservation Bulletin No. 2, a 40-page illustrated booklet now available for free distribution.

The booklet is the second of a series of conservation bulletins to be published by the Department of the Interior in line with its policy of encouraging prudent and intelligent use of the country's natural resources. The contents are designed to aid the irrigator to make the best use of his farm by proper irrigation.

The booklet deals with the technique of irrigation. It places emphasis on control of the flow of water at all stages of farm irrigation, from the time the water enters the farmer's head ditch to its final application in the field and illustrates several acceptable methods of control.

Information in the Farmer's Irrigation Guide was compiled by L. H. Mitchell, Irrigation Adviser, Bureau of Reclamation. Mr. Mitchell has had more than a quarter century of actual experience with the subject, as an irrigation farmer, project superintendent, construction engineer, and finally, as a specialist on the farm irrigation problems confronting the Bureau's 36 operating projects.

The first section of the Guide points out the importance of getting acquainted with surface and subsoil soil on the irrigated farm because of the variations in soil types which may be present even in a single field.

The second section contains instructions on grading the farm in order to get an even supply of irrigation water to all parts of the field, and the third section describes and illustrates three approved methods of distributing the water over the field in order to get an approximately equal amount of water to all plants.

The fourth section explains the use of a probe in determining water penetration in the soil, and discusses the water requirements of plants. Root spreads and depths of various plants are illustrated by drawings and photographs.

The fifth section contains information on building up the farm soil; the sixth shows how to lessen wind erosion by listing or ridging the soil; and the seventh and last section recommends personal experimentation by the farmer with water and plant food requirements of plants, on a small plot of land set aside for that purpose.

Mr. Mitchell first joined the Bureau in 1905, on his graduation from the University of Maine. He was assigned to the Lower Yellowstone reclamation project where, during the following 18 years, he obtained a thorough knowledge of irrigation practice, not only as an operating official but also as an irrigator, owing to the fact that he was owner of a project farm during part of this period. His knowledge of farm irrigation, therefore, represents an admirable combination of theory and actual practice.

From the Lower Yellowstone project Mr. Mitchell went to the Riverton project as construction engineer, and then to the Shoshone project as superintendent. Here the Willwood division was constructed and settled under his supervision. Its successful development unquestionably demonstrated the practical worth of applying the principles of good irrigation which he had been sponsoring, and in 1932 he was called to Washington, D. C., to give his entire attention to the problem of improving methods of irrigation on all reclamation projects.

Farmer's Irrigation Guide

United States Department of the Interior, Bureau of Reclamation

Twenty-seventh Annual Meeting of the Washington Irrigation Institute[1]

THE program offered by the twenty-seventh annual meeting of the Washington Irrigation Institute which took place in Yakima, Wash., on December 7-8, 1939, was one of the most interesting yet offered by the State organization. It consisted of a variety of subjects pertinent to irrigation and reclamation and embraced both technical and general discussions.

Opening with an address by President John S. Moore, the program included New Developments in Truck Crops, Soft Fruits, and Small Fruits, by members of the staff of the irrigation branch experiment station at Prosser, Wash., as well as Cooperative Irrigation Studies at the Irrigation Branch Experiment Station. These experiments are of particular interest to all irrigation sections of the State of Washington and bear a direct relationship to soil utilization studies that will be of immeasurable value to the Roza division of the Yakima project now under construction. When the 72,000 acres embraced in this division are brought under cultivation it is anticipated that the studies of the branch experiment station at Prosser will prove of material assistance to the settlers.

At the luncheon on December 7, Frederick Benz of Toppenish, Wash., a large grower of sugar beets, gave a most comprehensive address on the place of the sugar-beet industry in agriculture in the State of Washington.

Financial problems of irrigation districts was ably covered by Frank Maupin, secretary, Columbia Irrigation District, Kennewick; and J. B. Fink, director, Department of Conservation and Development for the State of Washington, delivered an excellent paper on the problems of the department in connection with loans made to irrigation districts by the State.

B. E. Stoutemyer, district counsel, Bureau of Reclamation, with offices in Portland, Oreg., delivered a very informative interpretation of the 1939 repayment law.

The institute was favored by the presence of L. H. Mitchell, irrigation adviser, Bureau of Reclamation, Washington, D. C., who gave two illustrated lectures, one dealing with practical measures for the control and eradication of weeds and the other dealing with fundamentals of irrigation.

H. A. Parker, Bureau of Reclamation Engineer, stationed at Ephrata, Wash., advised delegates to the institute concerning the economic survey being conducted on the Columbia Basin land.

One of the high lights of the convention was the annual banquet held on Thursday evening with Nat U. Brown, president of the Yakima Chamber of Commerce, acting as toastmaster. The speaker was F. A. Banks, supervising engineer, Bureau of Reclamation, in charge of construction of Grand Coulee Dam, who gave a most interesting word picture of the progress of the construction work to date and pointed out many of the salient features in connection with this engineering feat.

A new speaker on the program was R. B. Van Horn, head, department of civil engineering, University of Washington at Seattle, who spoke on Irrigation Systems—After Construction What? The subject of Van Horn's paper dealt with the fact that construction methods for irrigation have advanced by leaps and bounds in the past 10 or 20 years and that when a project is completed their need by no question adds to the stability of its construction. He advocated that the maintenance and operation of completed projects be on the same efficient basis as the construction, and he emphasized the importance of having trained men to carry out such a program.

E. Y. Robinson, manager of the Naches-Selah Irrigation District, presented a paper on the Operation and Maintenance of Irrigation Canals, which was of the same general tenor as Mr. Van Horn's address, but in greater detail. Mr. Robinson offered many valuable suggestions on methods of operation and maintenance as worked out in practice over a period of years in his capacity as irrigation manager. His paper was very interesting, as well as instructive.

J. A. Ford, treasurer and director of the National Reclamation Association from Washington, was present throughout the institute sessions. On December 7 he gave an informal, though very complete, report on the Denver convention of the NRA.

The erosion-damage problem was ably handled by Jack W. Rodner, area conservator, Soil Conservation Service, with offices at Yakima, and Harry G. Nickle, assistant irrigation engineer, Soil Conservation Service of the Department of Agriculture, and attached to the branch experiment station at Prosser.

C. E. Crownover, construction engineer in charge of the Roza division of the Yakima project, gave a progressive report on that project, and the delegates to the convention were guests of Mr. Crownover on Friday afternoon, December 8, at which time they were given an opportunity to see the project and what was being accomplished.

John S. Moore, of the Bureau of Reclamation, Yakima, was reelected president for 1940, with W. C. Muldrow, of Benton City, first vice president, and John Faust, of Ellensburg, second vice president. The two directors elected were W. E. Stapleton, of the Northern Pacific Railway, Seattle, and E. J. Brand, of Kennewick. In addition to these two, the other members of the institute directors for 1940 are C. M. Zedlker, Cashmere, Wash.; T. E. Brockhausen, Prosser; R. L. Howard, Toppenish; and Thomas B. Hill, Olympia. George C. Baer, manager of the Yakima Chamber of Commerce, was reelected secretary, and G. C. Finley, of Lind, was reelected treasurer.

The place of the 1940 annual meeting is to be determined at a later date by the board of directors.

The following resolutions were adopted at the meeting:

Noxious Weed Control

Whereas perennial noxious weeds have become a most serious menace to American agriculture, including reclamation, as well as other federally financed projects of the Western States; and

Whereas individual farmers cannot be expected to finance and solve this problem by themselves, as it can be solved only by coordinated effort covering the entire area affected; and

Whereas the economic structure of America, in its entirety, is affected by the encroachment of these weeds upon farmlands: Now therefore be it

Resolved, That the Washington Irrigation Institute support the efforts of the National Weed Committee of the National Plant Board in the establishment of a national noxious weed program to be partly supported by Federal funds on a cooperative State-Federal basis, and that from such Federal funds there be provided to the United States Bureau of Reclamation or any other Federal bureau concerned sufficient appropriations to conduct a program of prevention of perennial noxious weed infestations on new reclamation projects as well as on all other federally financed projects; and be it further

Resolved, That out of any Federal funds provided for noxious weed control, allocations be made to the proper Federal agencies for the eradication of these weeds upon federally owned or controlled lands, and that C. C. C. and W. P. A. regulations be modified to permit more effective use of the personnel of these agencies on properly sponsored weed-control projects.

Whereas the Washington Irrigation Institute is justly proud of the part it has played in the establishment and support of the irrigation branch experiment station at Prosser; and

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[1] A brief résumé of the program of the convention held in Yakima, Wash., December 7-8, 1939.

Whereas the station has, in the past 19 years, carried on most valuable and significant work in irrigation methods, water duty, in the development of new and improved crop varieties and practices, in pest control, fertilization problems, and many related fields; and

Whereas the farmers on our irrigated lands have reaped, in increased cash income, many times the cost of its support; and

Whereas many acute problems lie ahead in the stabilization of present irrigated agriculture as well as in the development of our vast areas of new land, thereby increasing the value of its services: Therefore be it

Resolved, That the financial support of this institution be increased, both by the State and by the United States Department of Agriculture, to the end that it may broaden the scope of its work, especially in the fields of water duty on our soils and soil classification in new irrigable areas; and be it further

Resolved, That we express deep appreciation of the splendid reports of constructive service being rendered, submitted by Superintendent Singleton and his assistants at this meeting.

Hydroelectric Power Fees

Be it resolved, That Washington Irrigation Institute express to the Governor and to the legislature its gratification that the license fees from hydroelectric power have been made available to the Reclamation revolving fund, as long advocated by this institute, to become available for the development of our natural resources through topographic mapping, stream-gaging, soil surveys, groundwater studies, etc.

We urge the continued support of these activities as basic data for successful future development of our natural resources.

Sugar Beets

Whereas large areas of the West are dependent, to a great extent, on the maintenance and growth of the sugar beet industry, and

Whereas the sugar beet industry provides so much labor in field, factory, manufacture of supplies, and transportation that each acre of sugar beets is far-reaching in its support of the economic structure of many large communities of American citizens; and

Whereas an orderly and sound expansion of beet plantings and processing as suitable land is developed is a reasonable and necessary condition on precedent to the building up of this country and should be encouraged; and

Whereas the lands to be brought in on Roza and Columbia Basin projects will be eminently suited to the production of this crop, and the settlers on these areas should not be deprived, by arbitrary restrictions, of the opportunity to grow one of the few sure cash crops they can rely upon to meet their water charges, and

Whereas the American sugar beet producers provide less than one-third of the requirements of our home market at the present time but could and should be supplying a major portion of its requirements to the economic advantage of the Nation as well as the western irrigated areas, and

Whereas our Government should adhere to the principles of American markets for American producers first; now therefore be it

Resolved by the Washington Irrigation Institute, That the Congress of the United States be urged, through proper legislation, to provide for the progressive, orderly expansion of the production of beet sugar within the United States and to maintain the beet-sugar industry on a reasonable income basis by quota regulations and adequate tariffs on foreign sugar; and be it further

Resolved, That a copy of this resolution be sent to the Secretaries of Agriculture, Interior, and State, and to the Senate and House of Representatives of the United States and to each of the Senators and Representatives of Western States in Congress.

State Rights in Water

Washington Irrigation Institute has always stood firm upon the principle of the State's right to the ownership and administration of its unappropriated waters, and it hereby endorses and supports in full the resolution recently adopted by the National Reclamation Association at Denver, as follows:

Whereas in the case of *Nebraska* vs. *Wyoming and Colorado*, now pending in the Supreme Court of the United States, the Federal Government through its Department of Justice, is asserting claim to all of the unappropriated waters, even of nonnavigable streams of the Western States, and also that the return flow resulting from the irrigation of Federal Reclamation projects is subject to control and disposition by the Federal Government, and, therefore, free from the control and supervision of the States in which such waters and projects are located, all of which is contrary to the fundamental principles of the water laws of these States, and

Whereas judicial decisions of the Supreme Court of the United States affirm that the control of waters of the States is vested in the States themselves, and not in the United States except to the extent that in respect to the interstate commerce needs of a particular Federal project on a navigable stream the control is expressly or by implication vested in the Federal Government under the interstate-commerce clause of the Constitution, and

Whereas in respect to Federal projects under the reclamation act, section 8 thereof, contains a specific subjection of these projects to the laws of the State in which they are situated, and exacts compliance therewith and recognition of rights acquired thereunder, and

Whereas the Flood Control Act of June 28, 1938, and later acts, authorizing the construction of certain public works on rivers for flood control and other purposes; the

West end of the Roza Diversion Dam, Roza Division, Yakima project, Washington. The river is being diverted over this weir while the diversion tunnel through the east weir is being filled with concrete

Pope-Jones Act, otherwise known as the Water Facilities Act, authorizing the construction of water conservation and utilization projects in the Great Plains and arid and semiarid regions of the United States; the Wheeler-Case Act; the Taylor Grazing Act, and possibly other acts authorizing the construction by Federal agencies of works for the control and use of waters in the Western States, contain no statement that the activities of the Federal Government, under the provisions of these various Federal acts, shall be carried out in conformity with State laws covering the ownership, control, and use of the waters of these Western States: Now therefore be it

Resolved by the National Reclamation Association:

1. That, to clear away all misunderstandings, these several acts and all similar acts be forthwith amended to include provisions, requiring, in the prosecution of all works designed for water conservation and use, that the particular Federal agency or department involved shall in all respects, save in the single one mentioned as falling under the interstate commerce clause of the Constitution, comply with State laws relating to the ownership, control, administration, and use of the waters of these Western States as is now required by section 8 of the National Reclamation Act in respect to projects constructed thereunder.

2. That this association renews its request to the various attorneys general of the Western States to the effect that at the proper time they appear in the interstate litigation above referred to, as "friends of the court," in support of the proposition that it is for the States and not for the Federal Government to control the waters of the States except to the extent that under the interstate commerce clause of the Constitution, a navigable stream may be involved, and even then only to the extent of the needs of the particular project on that stream, thus leaving the waters even of navigable streams, save to the extent mentioned, subject to the control of the States.

3. That it is suggested to the directors of this association that they consider the question of appearance of the association itself in such litigation at the appropriate time, should they deem it necessary; and be it further

Resolved, That copies of this resolution be sent to the Senators and Representatives in Congress, Governors and attorneys general of the Western States with a request for their assistance in carrying out the purposes of this resolution; also that this association, its officers and members likewise lend their own assistance.

Whereas the success of reclamation projects depends upon the successful building and operation of farms and homes by project settlers and every project settler often needs scientific and specialized advice and guidance in laying out and building his distribution system upon his farm and in learning his soil and the best methods of irrigating and farming it and in solving serious agricultural problems which are beyond his scientific and financial ability, and

Whereas irrigation specialists qualified to advise and instruct farmers upon irrigation and agricultural problems can be provided to act as advisors to project settlers (in cooperation) with experiment stations, county agents, and other agencies and,

Whereas the Bureau of Reclamation has had appropriations which could be used for providing such irrigation advisers, and no use has been made of such appropriations so that the amount thereof has been diminished from year to year; now therefore be it

Resolved, That the Washington Irrigation Institute recommends to the Bureau of Reclamation that irrigation specialists be provided for reclamation projects whose duty will be to advise with the project settlers individually and collectively for the purpose of solving their agricultural and irrigation problems and assisting the project settlers in perfecting their methods of irrigation and that the expense of such irrigation specialists and advisers be borne entirely by the Government.

Power Revenues

Whereas it is the policy of the United States Bureau of Reclamation to furnish adequate water supplies from reclamation projects to the irrigators at the lowest possible price, and the cost of reclamation in some instances is so great that repayment in 40 years from irrigation charges alone will impose a burden the farming industry cannot safely bear; and now therefore be it

Resolved, That the Washington Irrigation Institute favors the following policy in connection with Federal Reclamation projects: In cases where needed to reduce excessive cost of water to irrigators, such portion of the net revenue from the sale of the incidental electric power as in the judgment of the Secretary of the Interior shall be deemed proper as a fixed charge against power revenues shall be applied to the repayment of the reimbursable cost of the irrigation features of the project.

Whereas the problem of erosion of irrigated lands is of increasing importance, not only with respect to farms now in cultivation but with regard to new projects now being reclaimed, particularly the Roza and Columbia Basin, as it has been demonstrated that the aggregate losses of soil and water are enormous, resulting in decreased crop yields and serious depreciation in farm values, and

Whereas it is of vital importance that erosion of irrigated lands be prevented or controlled, and

Whereas much constructive work to this end has been performed by the United States Department of Agriculture, through the Soil Conservation Service, during the last several years which has resulted in material benefit to the irrigated sections of the State: Therefore be it

Resolved, That Washington Irrigation Institute strongly commends the Conservation Service of the United States Department of Agriculture on its work and urges the continuation and expansion of this program as rapidly as funds and personnel will permit and that such new lands as will come under water in the immediate future be studied for the purpose of preventing erosion losses and loss of soil fertility; and be it further

Resolved, That copies of this resolution be forwarded to the Chief of the Soil Conservation Service, Washington, D. C., and to the Regional Conservator, Spokane, Wash.

Settlement Policies

The settlement and development of the lands of the Roza and Columbia Basin projects will soon be actively under way, and the future success of the projects in large measure depends upon the principles that are followed and the policies that are adopted with respect to these problems.

This history of reclamation development in the West and the experience of Washington Irrigation Institute during the 27 years of its existence demonstrate beyond question that where projects are settled by men experienced in farming and so equipped financially and otherwise as to require the minimum of assistance, the future success of the settler and the project is practically assured. On the other hand, it has been demonstrated that where settlers have neither experience nor finances, but must be provided with practically everything in the way of housing and equipment, the chances for success are extremely remote. We submit that experience has demonstrated that endeavoring to provide for the needy and the destitute by establishing them as settlers on a reclamation project is the most costly form of relief; that in the end it does not benefit such settler, while serving as a deterrent to the success of the independent settler and the project as a whole.

We commend the policies that were followed in the settlement of the Kittitas Reclamation project and point to their absolute success. We recommend that similar policies be followed in the settlement of the Roza and Columbia Basin projects and that every effort be made to settle those projects with experienced and independent farm families who are capable of working out their own salvation with the help of proper information and advice. We submit that in such a course lies the best assurance of ultimate success.

Columbia Basin

Washington Irrigation Institute expresses its gratification that since its last meeting, largely through the efforts of officials of the Bureau of Reclamation and of the Department of Conservation and Development, the recommendations of the Institute looking to the orderly development of Columbia Basin lands are well on the way to accomplishment. The needed State legislation has been drawn and passed, and the steps leading to the organization of the irrigation districts are well advanced.

In view of the urgent need for this great outlet for our landless people, Washington Irrigation Institute strongly urges that the Congress make regular and sufficient appropriations for the orderly prosecution of construction work upon Columbia Basin project.

Whereas the State of Washington now has some 3 millions of dollars of its reclamation revolving fund invested in the bonds of 80 irrigation, drainage and dyking districts, large and small, and

Whereas these districts are scattered all over our State, many—perhaps most—of them small and isolated and not financially able to maintain a complete and trained clerical, engineering and legal staff, and

Whereas the opportunity exists for the Department of Conservation and Development to render a large and continuing service to this group of projects and others in need of such service, by setting up a personnel in its Division of Reclamation which shall be competent to advise these districts on the varied problems of district engineering, accounting and management, and generally concern itself with the problems of repayment of this 3 millions of dollars into the reclamation fund; Now therefore be it

Resolved, That this institute believes that it will be good business for the State, and of great benefit to the reclamation districts, to make proper appropriations for such functions in the Department of Conservation and Development and so recommends to the legislature; and be it further

Resolved, That this institute appreciates the difficulties inherent in the administration of the reclamation revolving fund, and expresses its belief that this fund has, for the past several years, been handled with the sympathetic consideration for the needs of the districts, tempered by a lively sense of responsibility to the public for its safe and sound use; and

Resolved further, That copies of this resolution be sent to the appropriate organizations and parties interested.

Charles W. Farmer Retires

ON November 14 Charles W. Farmer, superintendent of construction on the Boise project, reached his seventieth year and retired on December 1, 1939, after almost continuous service with the Bureau of Reclamation since 1907.

Mr. Farmer's career has been synonymous with the development of power and irrigation in southern Idaho. He first came to Idaho in 1896 and has made Boise his headquarters since 1898. In the early 1900's he played an important part in the construction of a number of privately financed development projects, including Swan Falls Dam and power plant, Horseshoe Bend power plant, the Barber Dam and power plant, and Grimes Pass Dam and power plant. In 1908 Mr. Farmer pioneered freighting with a tractor and organized the carpenter work on the Salmon River Dam, one of the early high dams in southern Idaho. In 1909 and 1910 he was in charge of building the lower Salmon Falls Dam and power plant, and in 1912 he helped a struggling contractor out of a hole on the second American Falls power plant.

His career with the Bureau of Reclamation began in 1907 at Jackson Lake Dam, and during the next several years he worked intermittently as construction foreman on the Minidoka and Boise projects. In 1911 he became general foreman on the construction of the Boise diversion power plant and in 1913 he returned to Jackson Lake Dam as superintendent of construction. In 1915 Mr. Farmer took a flier in building contracting for himself and made it pay. He returned to the Bureau in 1918 as superintendent of construction on the Minidoka project in connection with the moving of American Falls town preliminary to building the dam. In 1924 he took charge of the construction of the Black Canyon Dam power plant. From February 1928 to May 1930, as superintendent of construction, he played an important part in the construction of the Kittitas division of the Yakima project. The construction work on this division included a diversion dam, several unusually high head siphons, tunnels, concrete-lined canals, and a high head pressure tunnel under the Yakima River. He returned to the Boise project in 1930 to guide and direct the inspection on the Deadwood Dam. This assignment was followed by a similar one on the Cle Elum Dam for the Yakima project.

In 1933 Mr. Farmer was acting as superintendent of construction on the Owyhee project, where he served until the end of 1935. In January 1936 he took charge of the raising of Arrowrock Dam on the Boise project. This important assignment, which lasted until February 1938, was followed by a period of several months in which he supervised the foundation investigations for Twin Springs Dam, involving the excavation of numerous small tunnels and shafts. Mr. Farmer continued with active construction work on the Boise and Owyhee projects until his retirement.

Before coming to Idaho Mr. Farmer spent many years in the construction and operation divisions of the Santa Fe Railroad. He first worked with concrete in 1888 in the

Mr. Farmer is presented with a beautiful onyx-base clock; Mrs. Farmer (seated) is recipient of a large bouquet of autumn flowers. J. L. Savage, chief designing engineer, is standing next to Construction Engineer R. J. Newell, at extreme right

construction of abutments for a railroad bridge. The cement for this work was imported from Europe in barrels. The concrete expert came from England to direct the use of a product which was still new. At that time the portland cement industry in the United States was very young and many believed the imported cements were superior. Charlie Farmer, at 18 years of age, as he operated a No. 2 shovel on the mixing board, did not realize that concrete would play such an important part in his career nor that this English expert was the forerunner of numerous technicians to be dealt with in the years to come. But concrete fascinated him. He worked with it, watched it, and experimented with its mixtures and uses. Today he is still following each advance in the science of concrete with interest and satisfaction. Many of our present-day practices were strongly advanced by Mr. Farmer, but he was restrained at times with the argument that the costs were not justified.

His early life in the Middle West, before moving to Boise, was largely spent on railroad construction, where he gathered a vast amount of practical experience. This period of his life would no doubt be most interesting, but we must consider that our source of information is a construction man and a truly modest one. We do know, however, that when the "Cherokee Strip" was opened up in Oklahoma, Charlie was there with a good horse under him and most of 20,000 contestants to beat. His goal was a lot in the town of Perry, Okla., which he achieved, and probably, what is more notable, he successfully defended his claim against hundreds who arrived too late but attempted to profit by the use of force. In 1891 he was engaged in numerous activities around Denver, Colo., including mining and the construction of a concrete-lined water supply reservoir. We also know that he was in San Francisco working on reconstruction after the disastrous earthquake and fire. Doubtless there are many other tales of adventure that would make fascinating reading; but after all the great adventures in the life of Charles W. Farmer are the building of structures which will add to the wealth and comfort of mankind.

Prior to his advancement to the supervision of construction work Mr. Farmer was employed as a skilled mechanic in several lines. He had wide experience with steam engines, the use and treatment of metals, and in carpentry, both in heavy construction and on buildings. He spent considerable time studying to qualify himself, not only as a craftsman but also as a professional in the construction industry. He attended a trade school in St. Louis, studied under an architect in Portland, and did some valuable correspondence work. These pursuits, together with his first-hand experience, gave him a remarkable background for meeting the practical and technical problems encountered in the years that followed.

In his long and successful career in construction Mr. Farmer has made a host of friends. Men from every branch regard him with admiration and affection. Leading engineers—A. J. Wiley, F. E. Weymouth, J. L. Savage—have known him intimately and have depended on his field work, and big-time contractors have welcomed his assignment to their jobs. Many young engineers have benefited by his association and his fatherly interest in their careers. His kindness, modesty, and loyalty make working with him a real pleasure. His energy, thoroughness, and good judgment on the job are proverbial. While Mr. Farmer's retirement is a distinct loss to the Bureau, we are happy to know that he will continue to be active in construction.

NOTES FOR CONTRACTORS

Specification No.	Project	Bids opened	Work or material	Low bidder		Bid	Terms	Contract awarded
				Name	Address			
		1939						*1939*
1294-D	Rio Grande, N. Mex.	Nov. 13	Pipe fittings, valves, and accessories for the Elephant Butte power plant.	Midwest Piping & Supply Co., Inc.	St. Louis, Mo.	[1] $2,311.41	Discount 2 percent, F. o. b. Engle, N. Mex.	Nov. 28
						[2] 4,399.55	Discount 2 percent, F. o. b. St. Louis.	Do.
						[3] 542.65	Discount 2 percent, F. o. b. Engle, N. Mex.	Do.
1300-D	Colorado-Big Thompson, Colo.	Nov. 16	Weather stripping 6 duplex cottages at Estes Park headquarters.	Ideal Metal Weather Strip Co.	Boulder, Colo.	295.00		Nov. 25
1301-D	Uncompahgre, Colo.	Nov. 24	One 13- by 11.25-foot fixed wheel gate for the inlet replacement at Gunnison Tunnel.	American Bridge Co.	Denver, Colo.	4,963.00	F. o. b. Gary, Ind.	Nov. 29
1298-D	Boise-Payette, Idaho	Nov. 21	Structures, "A"-Line Canal laterals 20.4 to 32.3.	F. R. Knowlton	Layton, Utah	21,446.00		Dec. 5
1299-D	do	Nov. 22	Structures, "D"-Line Canal laterals 24.6 to 38.5.	Fife & Co.	Nyssa, Oreg.	23,656.50		Do.
835	Boulder Canyon, Ariz.-Nev.	May 15	2 governors with pumping equipment for units A-1 and A-2, Boulder power plant.	Baldwin Southwark Corporation.	Eddystone, Pa.	[4] 44,450.00	F. o. b. Rockford, Ill.	Do.
878	do	Nov. 16	Main and auxiliary control equipment, automatic oscillographs, battery distribution switchboard, auxiliary power control equipment, and air circuit breakers.	General Electric Co	Schenectady, N. Y.	[4] 5,277.25	F. o. b. Boulder City, Nev.	
				Roller-Smith Co.	Bethlehem, Pa.	[5] 5,152.00	do	Nov. 24
879	All-American Canal, Calif.	Oct. 18	Placing clay blanket on bottom and side slopes of All-American Canal, station 245+00 to station 1029+48.	Mark L. Hart	Orange, Calif.	57,563.60		Do.
1292-D	Colorado-Big Thompson, Colo.	Oct. 12	Construction of 115-kilowatt transmission line, 54 miles long, Greeley to Fort Morgan, with extensions to Wiggins (6 miles) and Brush (10½ miles).	Larson Construction Co.	Denver, Colo.	33,364.50		Dec. 2
B-39014-D.	Columbia Basin, Wash.	Nov. 13	500,000 linear feet of 1-inch o. d. black steel pipe or tubing.	National Electric Products Corporation.	Pittsburgh, Pa.	[2] 25,000.00	Discount 5 percent, F. o. b. Odair, Wash.	Nov. 30
1303-D	Central Valley, Calif.	Nov. 29	Stop-log guides and appurtenances	Arthur J. O'Leary & Son Co	Chicago, Ill.	26,000.00	Discount ½ percent, F. o. b. Chicago.	
1304-D	Columbia Basin, Wash.	Nov. 28	Gates and gate hoists	Valley Iron Works	Yakima, Wash.	[1] 1,015.00	Discount 5 percent	Dec. 6
				Western Foundry Co.	Portland, Oreg.	[2] 498.00	Discount ½ percent	Do.
				Valley Iron Works	Yakima, Wash	[3] 1,850.00	Discount 5 percent	Do.
1305-D	do	Dec. 1	2 aluminum folding doors for Grand Coulee power plant.	The Flour City Ornamental Iron Co.	Minneapolis, Minn.	12,990.00	F. o. b. Minneapolis.	
881	Minidoka, Idaho	Nov. 27	Turbine governor generator power transformers and high-voltage switching equipment for Minidoka power plant.	American Transformer Co.	Newark, N. J.	13,020.00	F. o. b. Acequia, Idaho.	
				Pacific Electric Manufacturing Corporation.	San Francisco, Calif.	3,620.00	do	Dec. 8
				National Electric Co.	Birmingham, Ala.	342.00	do	Do.

[1] Item 1.
[2] Item 2.
[3] Item 3.
[4] Schedule 2.
[5] Schedule 4.

Montanans Dedicate Fresno Dam

Fresno Dam, Milk River project, Montana

ON November 7, 1939, the $2,000,000 Fresno Dam, on the Milk River project, Montana, was dedicated in the presence of 1,200 persons, who braved threatening weather to attend the dedication service and demonstrated a realization of the economic importance of this structure. The attendants included not only Milk River Valley farmers, but more than 200 civic leaders of northern Montana, many of whom have given aid to the project for a decade or more. The principal speaker at the exercises was H. B. Brooks, editorial writer of the Great Falls Tribune and long a leader in urging construction of the dam.

The speaker commented on the significance of the plan of financing the dam, which includes contributions toward the cost of the structure by the towns, large business interests, and other beneficiaries of the water storage in addition to the farmers who use the water for irrigation. He said in part:

"We have been among the pioneers in establishing the principle which I believe ultimately must be considerably expanded. When water on the land greatly increases the amount of new wealth taken from the soil, the farmer is not the sole beneficiary. In fact, he is often not the chief beneficiary. That new wealth spreads into the towns, into the coffers of the county and the State, to the utility companies serving the area and, in the end, back into the treasuries of manufacturers, who find in the irrigation areas of the West so large a market for their goods.

"The Montana irrigation law directly recognizes that fact by making the initial cost of a State water project a public expenditure and not a loan. The Federal Government has begun to grant through one device and another a measure of subsidy to some reclamation undertakings and the multiple purpose dam, which combines irrigation, power, flood control, and recreation purposes, is a recognition of the fact that the farmer is not the sole beneficiary of water conservation and should not be expected to pay the whole of its cost.

"Our Government this year set aside immense funds for building several more great battleships, some of them costing $100,000,000 apiece. One of the purposes of a great navy is to protect our trade routes and commerce to South and Central American countries,

M. E. Bunger Felicitated by Associates

ON the evening of November 20, friends of M. E. Bunger, senior engineer on the Colorado-Big Thompson project, with headquarters at Estes Park, Colo., presented him with a Hamilton (reversible) wrist watch on the occasion of his transfer to secondary investigations in the Denver office. Ross L. Heaton, geologist of the project, represented the group in making the presentation.

M. E. Bunger presented with a Hamilton wrist watch by office associates where our businessmen are hopeful of finding new and bigger markets. But out here in the 11 Western States, those same business interests have already found a new market which did not exist before the canals turned the water on the land. This business now exceeds in volume of goods bought from the factories of the East the export trade to many foreign countries combined.

"To make this Nation strong and to promote its defense, the price of a battleship occasionally to aid in the conservation and use of western water supplies would be a wise and profitable investment for the Nation.

COLONEL FLY, 1858-1939

COL. B. F. FLY, prominently identified with the construction and development of the Yuma Mesa in Arizona, passed away December 10 at the home of his sister, Mrs. Kailula Jones, 305 East Fifth Street, Texarkana, Ark. In just 1 week, on December 17, he would have reached the age of 81. He had been in failing health for the past 10 years. This notice is given in the ERA in order that his many friends in Reclamation territory might be advised of his death.

Col. Fly's unceasing efforts in Washington to secure the approval of "his beloved" Yuma Mesa development started in 1916. Four years later he officiated at the turning of the first spade of earth on the Mesa, marking the commencement of construction. From then, until he was forced to retire due to his failing health, he maintained a lively interest not only in the Yuma Mesa development but in all progress under the Federal Reclamation policy. The gratifying growth of the project during his enforced retirement has been an unending joy to the colonel.

At Yuma, Ariz., the city's airport was named "Fly Field" in honor of Colonel Fly.

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CUT ALONG THIS LINE

(Date)....................................

COMMISSIONER,
Bureau of Reclamation,
Washington, D. C.

SIR: I am enclosing my check [1] (or money order) for $1.00 to pay for a year's subscription to THE RECLAMATION ERA.

Very truly yours,

January 1940.

(Name)..

(Address)..

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[1] Do not send stamps.

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Projects under construction or operated in whole or in part by the Bureau of Reclamation

Project	Office	Official in charge		Chief clerk	District counsel	
		Name	Title		Name	Address
All-American Canal	Yuma, Ariz.	Leo J. Foster	Constr. engr.	J. C. Thrailkill	R. J. Coffey	Los Angeles, Calif.
Belle Fourche	Newell, S. Dak.	F. C. Youngblutt	Superintendent	J. P. Siebeneicher	W. J. Burke	Billings, Mont.
Boise	Boise, Idaho	R. J. Newell	Constr. engr.	Robert B. Smith	B. E. Stoutemyer	Portland, Oreg.
Boulder Canyon [1]	Boulder City, Nev.	Irving C. Harris	Director of power	Gail H. Baird	B. J. Coffey	Los Angeles, Calif.
Buffalo Rapids	Glendive, Mont.	Paul A. Jones	Constr. engr.	Edwin M. Bean	W. J. Burke	Billings, Mont.
Buford-Trenton	Williston, N. Dak.	Parley R. Neeley	Res. engr.	Robert L. Neuman	W. J. Burke	Billings, Mont.
Carlsbad	Carlsbad, N. Mex.	L. E. Foster	Superintendent	E. W. Shepard	H. J. S. Devries	El Paso, Tex.
Central Valley	Sacramento, Calif.	W. R. Young	Supervising engr.	E. R. Mills	R. J. Coffey	Los Angeles, Calif.
Shasta Dam	Redding, Calif.	Ralph Lowry	Constr. engr.		R. J. Coffey	Los Angeles, Calif.
Friant division	Friant, Calif.	R. B. Williams	Constr. engr.		R. J. Coffey	Los Angeles, Calif.
Delta division	Antioch, Calif.	Boden, Oscar G.	Constr. engr.		R. J. Coffey	Los Angeles, Calif.
Colorado-Big Thompson	Estes Park, Colo.	Porter J. Preston	Supervising engr.	C. M. Voyen	J. R. Alexander	Salt Lake City, Utah.
Colorado River	Austin, Tex.	Ernest A. Moritz	Constr. engr.	William F. Sha	H. J. S. Devries	El Paso, Tex.
Columbia Basin	Coulee Dam, Wash.	F. A. Banks	Supervising engr.	C. B. Funk	B. E. Stoutemyer	Portland, Oreg.
Deschutes	Bend, Oreg.	C. G. Fisher	Constr. engr.	Noble O. Anderson	B. E. Stoutemyer	Portland, Oreg.
Gila	Yuma, Ariz.	Leo J. Foster	Constr. engr.	J. C. Thrailkill	R. J. Coffey	Los Angeles, Calif.
Grand Valley	Grand Junction, Colo.	W. J. Chiesman	Superintendent	Emil T. Ficenec	J. R. Alexander	Salt Lake City, Utah.
Humboldt	Reno, Nev.	Chas. S. Hale	Constr. engr.		J. R. Alexander	Salt Lake City, Utah.
Kendrick	Casper, Wyo.	Irvin J. Matthews	Constr. engr.[2]	George W. Lyle	W. J. Burke	Billings, Mont.
Klamath	Klamath Falls, Oreg.	B. E. Hayden	Superintendent	W. I. Tingley	B. E. Stoutemyer	Portland, Oreg.
Milk River	Malta, Mont.	H. H. Johnson	Superintendent	E. E. Chabot	W. J. Burke	Billings, Mont.
Fresno Dam	Havre, Mont.	H. V. Hubbell	Constr. engr.	E. F. Chabot	W. J. Burke	Billings, Mont.
Minidoka	Burley, Idaho	Dana Templin	Superintendent	G. C. Patterson	B. E. Stoutemyer	Portland, Oreg.
Minidoka Power Plant	Burley, Idaho	Samuel A. McWilliams	Resident engr.		B. E. Stoutemyer	Portland, Oreg.
Moon Lake	Provo, Utah	E. O. Larson	Constr. engr.	Francis J. Farrell	J. R. Alexander	Salt Lake City, Utah.
North Platte	Cuernsey, Wyo.	C. F. Gleason	Supt. of power	A. T. Stimpfig	W. J. Burke	Billings, Mont.
Ogden River	Provo, Utah	E. O. Larson	Constr. engr.	Francis J. Farrell	J. R. Alexander	Salt Lake City, Utah.
Orland	Orland, Calif.	D. L. Carmody	Superintendent	W. D. Funk	R. J. Coffey	Los Angeles, Calif.
Owyhee	Boise, Idaho	R. J. Newell	Constr. engr.	Robert B. Smith	B. E. Stoutemyer	Portland, Oreg.
Parker Dam Power	Phoenix, Ariz.	E. G. Koppen	Constr. engr.	George B. Snow	R. J. Coffey	Los Angeles, Calif.
Pine River	Vallecito, Colo.	Charles A. Burns	Constr. engr.	Frank E. Gawn	J. R. Alexander	Salt Lake City, Utah.
Provo River	Provo, Utah	E. O. Larson	Constr. engr.	Francis J. Farrell	J. R. Alexander	Salt Lake City, Utah.
Rio Grande	El Paso, Tex.	L. R. Fiock	Superintendent	H. H. Berryhill	H. J. S. Devries	El Paso, Tex.
Elephant Butte Power Plant	Elephant Butte, N. Mex.		Resident engr.	H. H. Berryhill	H. J. S. Devries	El Paso, Tex.
Riverton	Riverton, Wyo.	H. D. Comstock	Superintendent	C. B. Wentzel	W. J. Burke	Billings, Mont.
Salt River	Phoenix, Ariz.	E. G. Kappen	Constr. engr.	Edgar A. Peek	R. J. Coffey	Los Angeles, Calif.
Sanpete	Provo, Utah	E. O. Larson	Constr. engr.	Francis J. Farrell	J. R. Alexander	Salt Lake City, Utah.
Shoshone	Powell, Wyo.	L. J. Windle	Superintendent [2]	L. J. Windle [2]	W. J. Burke	Billings, Mont.
Heart Mountain division	Cody, Wyo.	Walter F. Kemp	Constr. engr.	L. J. Windle [2]	W. J. Burke	Billings, Mont.
Sun River	Fairfield, Mont.	A. W. Walker	Superintendent		W. J. Burke	Billings, Mont.
Truckee River Storage	Reno, Nev.	Charles S. Hale	Constr. engr.		J. R. Alexander	Salt Lake City, Utah.
Tucumcari	Tucumcari, N. Mex.	Harold W. Mutch	Engineer	Charles L. Harris	H. J. S. Devries	El Paso, Tex.
Umatilla (McKay Dam)	Pendleton, Oreg.	C. L. Tice	Reservoir supt.		B. E. Stoutemyer	Portland, Oreg.
Uncompahgre: Repairs to canals	Montrose, Colo.	Denton J. Paul	Engineer	Ewalt P. Anderson	J. R. Alexander	Salt Lake City, Utah.
Upper Snake River Storage [3]	Ashton, Idaho	I. Donald Jerman	Constr. engr.[2]	Emmanuel V. Hillius	B. E. Stoutemyer	Portland, Oreg.
Vale	Vale, Oreg.	C. C. Ketchum	Superintendent		B. E. Stoutemyer	Portland, Oreg.
Yakima	Yakima, Wash.	J. S. Moore	Superintendent	Conrad J. Ralston	B. E. Stoutemyer	Portland, Oreg.
Roza division	Yakima, Wash.	Charles E. Crownover	Constr. engr.	Alex S. Harker	B. E. Stoutemyer	Portland, Oreg.
Yuma	Yuma, Ariz.	C. B. Elliott	Superintendent	Jacob T. Davenport	R. J. Coffey	Los Angeles, Calif.

[1] Boulder Dam and Power Plant. [2] Acting. [3] Island Park and Grassy Lake Dams.

Projects or divisions of projects of Bureau of Reclamation operated by water users

Project	Organization	Office	Operating official		Secretary	
			Name	Title	Name	Address
Baker (Thief Valley division) [1]	Lower Powder River irrigation district	Baker, Oreg.	A. J. Ritter	President	F. A. Phillips	Keating.
Bitter Root [4]	Bitter Root irrigation district	Hamilton, Mont.	G. R. Walsh	Manager	Elsie H. Wagner	Hamilton.
Boise [1]	Board of Control	Boise, Idaho	Wm. H. Tuller	Project manager	L. P. Jensen	Boise.
Boise [1]	Black Canyon irrigation district	Notus, Idaho	W. H. Jordan	Superintendent	L. M. Watson	Caldwell.
Burnt River	Burnt River irrigation district	Huntington, Oreg.	Edward Sullivan	President	Harold H. Hursh	Huntington.
Frenchtown	Frenchtown irrigation district	Frenchtown, Mont.	Edward Donlan	President	Ralph P. Schaffer	Huson.
Grand Valley, Orchard Mesa [3]	Orchard Mesa irrigation district	Grand Jctn., Colo.	C. W. Tharp	Superintendent	C. J. McCormich	Grand Jctn.
Huntley [4]	Huntley irrigation district	Ballatine, Mont.	E. E. Lewis	Manager	H. S. Elliott	Ballatine.
Hyrum [3]	South Cache W. U. A.	Wellsville, Utah	B. L. Mendenhall	Superintendent	Harry C. Parker	Logan.
Klamath, Langell Valley [1]	Langell Valley irrigation district	Bonanza, Oreg.	Chas. A. Revell	Manager	Chas. A. Revell	Bonanza.
Klamath, Horsefly [1]	Horsefly irrigation district	Bonanza, Oreg.	Henry Schmor, Jr.	President	Dorothy Eyers	Bonanza.
Lower Yellowstone [4]	Board of Control	Sidney, Mont.	Axel Persson	Manager	Axel Persson	Sidney.
Milk River: Chinook division [1]	Alfalfa Valley irrigation district	Chinook, Mont.	A. L. Benton	President	R. H. Clarkson	Chinook.
	Fort Belknap irrigation district	Chinook, Mont.	H. B. Bonefright	President	L. V. Bogy	Chinook
	Zurich irrigation district	Harlem, Mont.	G. A. Watkins	President	H. M. Montgomery	Chinook.
	Harlem irrigation district	Harlem, Mont.	Thos. M. Everett	President	Geo. H. Tout	Harlem.
	Paradise Valley irrigation district	Zurich, Mont.	R. E. Musgrove	President	J. F. Sharples	Zurich.
Minidoka: Gravity [1]	Minidoka irrigation district	Rupert, Idaho	Frank A. Ballard	Manager	O. W. Paul	Rupert
Pumping	Burley irrigation district	Burley, Idaho	Hugh L. Crawford	Manager	Frank O. Redfield	Burley.
Gooding [1]	Amer. Falls Reserv. Dist. No. 2	Gooding, Idaho	S. T. Baer	Manager	Ida M. Johnson	Gooding
Newlands [1]	Truckee-Carson irrigation district	Fallon, Nev.	W. H. Wallace	Manager	H. W. Emery	Fallon.
North Platte: Interstate division [4]	Pathfinder irrigation district	Mitchell, Nebr.	T. W. Parry	Manager	Flora K. Schroeder	Mitchell.
Fort Laramie division [4]	Gering-Fort Laramie irrigation district	Gering, Nebr.	W. O. Fleenor	Superintendent	C. G. Klingman	Gering.
Fort Laramie division [4]	Goshen irrigation district	Torrington, Wyo.	Floyd M. Roush	Superintendent	Mary E. Harrach	Torrington.
Northport division [4]	Northport irrigation district	Northport, Nebr.	Mark Iddings	Manager	Mabel J. Thompson	Bridgeport.
Ogden River	Ogden River W. U. A.	Ogden, Utah	David A. Scott	Superintendent	Wm. P. Stephens	Ogden, Utah
Okanogan [1]	Okanogan irrigation district	Okanogan, Wash.	Nelson D. Thorp	Manager	Nelson D. Thorp	Okanogan.
Salt Lake Basin (Echo Res.) [1]	Weber River Water Users' Assn.	Ogden, Utah	D. D. Harris	Manager	D. D. Harris	Layton.
Salt River [2]	Salt River Valley W. U. A.	Phoenix, Ariz.	H. J. Lawson	Superintendent	F. C. Henshaw	Phoenix.
Shoshone: Garland division [4]	Shoshone irrigation district	Powell, Wyo.	Paul Nelson	Acting irri. supt.	Harry Barrows	Powell.
Frannie division [4]	Deaver irrigation district	Deaver, Wyo.	Floyd Lucas	Manager	R. J. Schwendiman	Deaver
Strawberry Valley	Strawberry Water Users' Assn.	Payson, Utah	S. W. Grotegut	President	E. G. Breeze	Payson.
Sun River: Fort Shaw division [4]	Fort Shaw irrigation district	Fort Shaw, Mont.	C. L. Bailey	Manager	C. L. Bailey	Fort Shaw.
Greenfields division [4]	Greenfields irrigation district	Fairfield, Mont.	A. W. Walker	Manager	H. P. Wangen	Fairfield.
Umatilla: East division [1]	Hermiston irrigation district	Hermiston, Oreg.	E. D. Martin	Manager	Enos D. Martin	Hermiston.
West division [1]	West Extension irrigation district	Irrigon, Oreg.	A. C. Houghton	Manager	A. C. Houghton	Irrigon.
Uncompahgre [3]	Uncompahgre Valley W. U. A.	Montrose, Colo.	Jesse R. Thompson	Manager	H. D. Galloway	Montrose.
Yakima, Kittitas division [1]	Kittitas reclamation district	Ellensburg, Wash.	G. G. Hughes	Acting manager	G. L. Sterling	Ellensburg.

[1] B. E. Stoutemyer, district counsel, Portland, Oreg.
[2] R. J. Coffey, district counsel, Los Angeles, Calif.
[3] J. R. Alexander, district counsel, Salt Lake City, Utah.
[4] W. J. Burke, district counsel, Billings, Mont.

Important investigations in progress

Project	Office	In charge of—	Title
Colorado River Basin, sec. 15 (Colo., Wyo., Utah, N. Mex.)	Denver, Colo.	E. B. Debler	Senior engineer.
Fort Peck Pumping (Mont., N. Dak.)	Denver, Colo.	W. G. Sloan	Engineer.
Missouri River Pumping (N. Dak., S. Dak.)	Denver, Colo.	W. G. Sloan	Engineer.
Yellowstone Basin (Mont.)	Helena, Mont.	F. V. Munro	Engineer.
Big Horn Basin (Mont., Wyo.)	Denver, Colo.	W. G. Sloan	Engineer.
Mangum, North Canadian, Washita (Okla.)	Denver, Colo.	A. N. Thompson	Engineer.
Arkansas Valley (Colo., Kans.)	Denver, Colo.	A. N. Thompson	Engineer.
Bear River (Utah, Idaho, Wyo.)	Salt Lake City, Utah	E. G. Nielsen	Engineer.
Robert Lee (Tex.)	Austin, Tex.	E. A. Moritz	Construction engineer.
Duchesne-Sevier (Utah)	Salt Lake City, Utah	E. G. Nielsen	Engineer.
Williams, Hassayampa, Little Colorado (Ariz.)	Phoenix, Ariz.	Major O. Simons	Associate engineer

Issued monthly by the Bureau of Reclamation, Department of the Interior, as approved by the Director of the Budget. SALLIE A. B. COE, *Editor*.

SNOWS IN THE MOUNTAINS PREDICT IRRIGATION WATER SUPPLY

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Secretary Ickes Proposes Small Projects

Senator Carl Hayden, of Arizona, recently requested Secretary of the Interior Harold L. Ickes to furnish an outline of a reclamation program which would meet the needs of the West created by extended, critical drought, in response to which the Secretary, in a letter of January 18, 1940, to Senator Hayden, proposed a 5-year program of small project construction and the continuation of the regular reclamation construction program at the $50,000,000 to $60,000,000 a year rate.

The Secretary's letter is as follows:

JANUARY 18, 1940.

MY DEAR SENATOR HAYDEN:

Your letter dated December 18, 1939, discusses the long-continued drought in the Western States which has created a human problem of great magnitude. It also suggests that steps toward a solution of this problem are possible by a comprehensive program of water conservation and irrigation, and by extending the usual operations of the Bureau of Reclamation.

There are two distinct phases of the human problem caused by the extended drought: First, that of anchoring insofar as possible the remaining population in the drought areas, and this can be accomplished in part through irrigation developments; and, second, that of providing opportunities for the rooting in new soil of the people who have drifted to the far Western States from other areas, and this can be achieved in part by the completion of irrigation projects to utilize the water resources as yet unconserved in those States.

For a full decade now the drought has continued. While the area most critically affected has shifted from year to year, the general focus has been on the Great Plains area. In 1934 and again in 1936 severe drought was general in the West. While each new season has brought renewed hopes for general relief, the last 4 months of 1939 were drier over wider regions than any others in the decade. There are several reasons to fear that the worst has not as yet been experienced. Depletion of underground water and soil moisture has been so great that even normal rainfall in 1 or 2 years may not bring full relief.

That the migration westward of homeless people is keyed largely to the drought, although not all the migrants are from critical drought areas, has been widely assumed. The migration was reduced in 1937 and again in 1938, but it picked up sharply and coincidentally with the pinch of the severe 1939 drought.

Reliable estimates place at 75,000 families the number which has left the Great Plains drought area alone during the decade. More may have to go unless succored. Reliable information indicates that during the 10-year period 110,000 families migrated to California; 18,000 to Washington; 18,000 to Oregon; and 7,000 to Idaho. These were homeless people. Not all, however, were made homeless by drought. Some were cut loose from their moorings in other areas in other ways. It matters little to the victim or to the Nation, once the migrant has joined the hopeless army, what forced his enlistment.

The squads from this army which have been able to relocate themselves make up, according to the best estimates, only a very small percentage of the total number.

For the most part, the migrants are worthy people. They are victims of circumstances beyond their control. They place a responsibility upon their Government. This responsibility largely has been met so far by expedient and temporary measures.

Both in the critical drought area in the Great Plains and in the far Western States disproportionately high relief expenditures have resulted. As you suggest in your letter, the time probably is overdue when we look to such corrective work as can be undertaken.

Last year a start along this line was authorized with the appropriation of the Interior Department Appropriation Act of 1940 of $5,000,000 to develop a few irrigation projects in the Great Plains and other arid and semiarid regions on which this appropriation and some relief funds might be used. Several of these projects are now underway in Montana, North Dakota, and South Dakota. They must of necessity born of the meager water supplies available near usable lands be small, and they must because of relatively high per-acre cost be separated from the usual Federal Reclamation projects since they cannot be expected to return directly in dollars to the Treasury the full amount of their construction costs. In savings in future relief expenditures and in the prevention of human misery, however, they will make up the deficit uncounted times.

A program involving approximately $5,000,000 a year on a reimbursable basis for projects of this type and relief and nonreimbursable expenditures of $5,000,000 to $7,000,000 a year seems indicated. I am furnishing, as you suggested, an outline of a 5-year program proposed by the Bureau of Reclamation of this size, which could be carried forward efficiently.

Many of the projects proposed are far removed from the centers of relief load, and camp housing frequently will be necessary. This suggests the possibility that CCC camps might advantageously be used where relief laborers are deficient in number. Such construction provides excellent training and educational advantages for the young men of the Civilian Conservation Corps.

There can be no doubt that irrigation can and must occupy a prominent place in the plans for the stabilization of the Great Plains.

Now, turning to the other phase of the problem—that of providing new opportunities for the migrants—the new reclamation projects in the West provide the logical answer. Such great developments as Grand Coulee Dam, and others only smaller in size, will offer many new homes. At least $50,000,000 to $60,000,000 each year for several years to come could well be used by the Bureau of Reclamation in the construction of projects of this type which are wholly reimbursable.

An attempt was made by the Congress at its last session to give the penniless but worthy drought victims an equal opportunity to obtain such homesteads on irrigation projects as might be made available this year. The operation of another statute which expires in February 1940, however, through the granting of a 90-day preference to veterans, has made the new statute virtually inoperative. The homesteads were taken by veterans. Such matters as these should be taken care of in order to insure the most sensible use of the new lands to the greatest public good.

Sincerely yours,

(Sgd.) HAROLD L. ICKES,
Secretary of the Interior.

The outline of a 5-year program provided by Secretary Ickes included tentatively a proposal of projects in 16 Western States, the estimated reimbursable cost of which would be $24,100,000. The projects individually would encompass from 1,100 to about 20,000 acres and would range in cost from $25,000 to about $1,000,000.

PRICE
ONE
DOLLAR
A YEAR

THE RECLAMATION ERA

VOLUME 30 • FEBRUARY 1940 • NUMBER 2

Inverted Siphons, Gravity Main Canal

Gila Project, Arizona

By E. A. BLOUT, *Associate Engineer*

THE largest inverted siphons built by the Bureau of Reclamation have just been constructed on the Gravity Main Canal for the Yuma-Mesa division of the Gila project in southwestern Arizona, to carry the flow across the Gila River and Fortuna Wash, approximately 10 miles east of Yuma. Their completion was a singular construction achievement, particularly with reference to the Gila River, for although the tremendous floods that formerly deluged that channel are now curbed by six large storage dams in the upper regions of the watershed and several diversion structures on the lower courses, there was still danger of flash floods from storms in the desert areas. During construction, control of the large normal underground flow was essential and a great deal of consideration was given to this by the contractors when bidding on the work. Fortuna Wash, being much smaller and normally carrying no water, presented a problem somewhat simpler but still subject to the same extreme conditions.

Gila Siphon

In order to gain a satisfactory site for crossing the Gila River, the Gravity Main Canal was located along the base of the western and southern slopes of the Laguna Mountains to a point where the rocky slopes of the mountains break abruptly upstream along the river channel at nearly right angles, leaving a small blunt spur projection. Here conditions were decidedly advantageous for a siphon with rock foundations for the inlet transitions and the spur projection forming a natural cut-off wall for protection of the entrance. From an economical standpoint it would have been impracticable to extend the siphon to the rock slopes of the opposite side, and the outlet was established on alluvial ground within the river flood plane, well beyond the normal channel, leaving a river section of sufficient capacity to discharge a flow of 150,000 cubic feet per second.

For the initial development of the canal, the siphon is a single concrete barrel of circular inside section 19 feet, 6 inches in diameter and 2,000 feet in length between the portals, with open transitions at each end, and a 19.5- by 22-foot fixed wheel counterbalanced gate at the entrance to be used in conjunction with an automatic spillway and wasteway 1,390 feet upstream for regulating the flow into the siphon or closing the canal at this point. Under the present development, the siphon has capacity for a flow of 2,200 cubic feet per second at a velocity of 7.37 feet per second. Ultimately, when the canal is enlarged for 6,000 cubic feet per second, two similar barrels with corresponding features will be constructed immediately to the right of and parallel to the present unit.

Front cover Illustration

WEDGED between the steep walls of Seminoe Canyon, the 296-foot Seminoe Dam blocks the North Platte River and will store 1,020,000 acre-feet of water for the fertile arid lands ot the Kendrick Federal Reclamation project, Wyoming. The first 35,000-acre unit of irrigable land will be opened for settlement in 1940 or 1941.

The open transitions leading from and to the normal canal at each end of the siphon are 60 feet in length with warped walls supported by counterforts on the left and vertical walls reinforced as cantilevers on the right. Facilities for completing the transitions for the ultimate development, without interrupting service in the canal, were provided by constructing 30-foot sections of the future addition from the ends of the right walls of the present structure.

Between the open transitions and barrel, closed transitions 39 feet in length complete the change in section from trapezoidal for the normal canal to circular for the barrel. The open transitions are separated from the rest of the siphon by water seal bell joints, in which rubber water stops have been used for the sealing elements.

The gate structure at the entrance is integral with the closed transition, the walls of the latter being offset sufficiently to accommodate the width of the gate and to provide the necessary area for the columns of the 10-foot 6-inch by 26-foot tower, 28 feet high. The hoist mechanism consists of a set of sprocket gears at each end of the gateway over which passes a roller link chain between the gate and counterweight, driven by torque shafts from a centrally located gear reduction unit. Power for operation is supplied by a gasoline engine. At the outlet, grooves for stop logs were provided for closing the siphon in an emergency.

The barrel and closed transitions are a monolithic unit, constructed in sections 30 feet long, or less, where the exigencies of the work required. At the joints a continuous $\frac{3}{16}$- by 8-inch wrought iron water stop, covered with asphalt emulsion to protect the metal against corrosion, was placed around the section halfway between the inside and outside surfaces. In section, the outside of the barrel is circular above the horizontal diameter, vertical on the sides, and formed by 2:1 slopes tangent to an arc segment concentric with the inside section at the base. Normally the thickness of the concrete is 20 inches at the top and bottom and 22 inches at the sides. However, for a distance of 580 feet under the deepest channel of the river, these dimensions were increased to 23 inches at the bottom, 25 inches at the sides, and 30 inches at the top.

Two rows of 20-foot cut-off steel sheet piling, one along each side of the barrel, were driven into the foundations from contacts with the rock at the inlet end to the closed outlet transition, to prevent displacement of the foundation by ground water piping or channeling under the structure. The tops of the individual piles were left 12 inches above the lower edges of the sides and fastened to the barrel by a 1-inch bolt embedded in the concrete.

Protection against river scour was provided by placing a heavy rockfill on both sides of the barrel. The fill was placed from the natural slopes of the excavation which were approximately 1½:1 from the bottom of the sides of the barrel, to a level with the top of the concrete downstream and to a —3:1 slope from the top of the concrete upstream. Under the deepest part of the channel, for a distance of 150 feet, the rock section was increased to a depth of 4 feet above the barrel. Over the rock, the original material was replaced to the level of the river bed, or to a minimum depth of 4 feet.

The canal approach to the siphon, from a point 498 feet upstream from the open transition, was constructed with the right embankment of sufficient width to permit a portion to be removed when the canal section is excavated to its ultimate capacity. Beyond the open transition, a continuation of the right embankment was extended around the entrance and across the barrel to the slopes of the spur on the opposite side of the siphon. Compacted materials were placed in the permanent portion of the embankment within the canal reach, and tamped backfill was placed behind the open transition walls.

From the siphon outlet both banks were constructed for a distance of 1,000 feet across the remainder of the river channel. In this reach, it was therefore advantageous to construct the canal with the ultimate section having a bottom width of 100 feet, and embankments 19.5 feet in height. For a distance of 725 feet downstream from end of the closed transition, both embankments and a 24-inch layer on the bottom of the canal were placed of compacted materials.

Beyond that point, the embankments were cast from canal excavation, and compacted materials were used only for lining the inside slopes and bottom of the canal. Tamped backfill was placed behind the wing walls of the open transition, and loose fill was used to complete the enclosure around the outlet.

A riprap blanket was placed on the outside slopes of the canal embankment near the ends of the siphon to protect them against floods. The blanket is 3 feet wide at the top with a 3:1 slope on the exposed surface and a 2:1 slope on the embankment side.

Construction

Construction of the siphon was started with the excavation for the transitions at the outlet end, from which the work advanced into the canal section downstream and into the barrel reach upstream. The excavation program for the barrel, as a result of the necessity of unwatering the trench, was governed by the concrete placing schedule and only the minimum of trench required for essential operations was opened. This minimum distance was approximately 700 feet, of which 100 to 200 feet were required for excavation, 100 feet for driving steel sheet-piling, 200 feet for placing reinforcement steel and forms, and 300 feet for the completed barrel during the curing period.

The steel sheet piling under the barrel was driven with a No. 7 pile-driving hammer in a set of timber leads built on the job and suspended from a 1-yard dragline reconstructed for the purpose. Air was substituted for steam as the power medium, and was supplied by a portable 500-cubic-feet-per-minute compressor, supplemented by a second machine of 300-cubic-feet-per-minute capacity. Concrete materials were delivered to the point of placement in batches, and there mixed in a 1-yard paving machine from which it was placed directly in the forms. Pneumatic vibrators and spades were used in puddling the mix.

Metal forms were an outstanding contribution to the efficiency of the work. Uniform interlocking panel sections, 2 feet wide by 3 feet long, were used for the vertical and plane surfaces. A set of steel forms, 30 feet long, constructed to exact concrete dimensions was used for both sides of the barrel with the exception of the invert. This part of the section was formed with a heavy metal traveling screed, operated by a hand winch, of the same width as the invert, and was finished by hand floating and troweling.

Selected materials for the compacted earth sections were obtained from a borrow pit approximately one-third mile south of the siphon. This material was rather coarse but fairly uniform in grading. Compaction was obtained by rolling with a large tamping roller especially built for this work. The roller consisted of two oscillating drums 4½ feet in diameter and 5 feet long, each of which when loaded with sand and water, weighed 26,520 pounds. Each tamping foot was 8 inches long with a tamping area of 6.5 square inches. There were 22 horizontal or longitudinal rows of feet, each alternate row containing 5 and 6 feet, respectively, with the feet staggered in adjacent rows. The average pressure, per unit of area, obtained by this roller was no greater than that (340 pounds per square inch) of the equipment in general use by other contractors on similar work on the All-American Canal, but the advantage lay in the ability of the roller to exert much greater pressure on any rock, or localized material tending to lift the roller. The heavier roller operated very smoothly and little bouncing was observed, for although the material from this borrow pit contained a larger percentage of rock than other borrow areas for similar materials, no stones having maximum dimensions of more than 5 inches were permitted to be placed in the embankments. In operation, the larger diameter of the drum enabled the 13-ton roller to be handled quite easily by an RD-8 caterpillar tractor. The only difficulty was the excessive wearing of the feet, which, as a rule, had to be built up once a month. The results obtained with this roller were so convincing that the type has since been used on other projects.

Rock for fills and riprap was available from canal excavation, approximately 1,500 feet downstream from the siphon, and advantage of this was taken by quarrying the material to the limits of the ultimate section, thus gaining full capacity for the canal without cost for excavation.

Unwatering Foundations

Unwatering the foundations for the Gila River siphon was a precarious operation. The hazard incident to the entire work was very great, due to the uncertainty of the character of the pervious strata carrying the underground flow at the structure site. The Gila River drains the entire southern half of the State of Arizona and a portion of New Mexico. It is a dry river most of the time, receiving its flow from storms and for normal run-offs from the mountain areas in the northern and eastern part of the State, and to a lesser extent, from local cloudbursts in the summertime. In years past, the flood discharges have been very serious, the worst on record being 199,000 cubic feet per second in January 1916, and on several occasions, the flow has exceeded 75,000 cubic feet per second. Although storage dams, constructed within recent years, on the Gila River and its tributaries have greatly decreased the danger of serious floods in the lower reaches, nevertheless during the progress of the work the river was subject to uncontrolled floods from the contributing Verde and Hassayampa Rivers in Central Arizona.

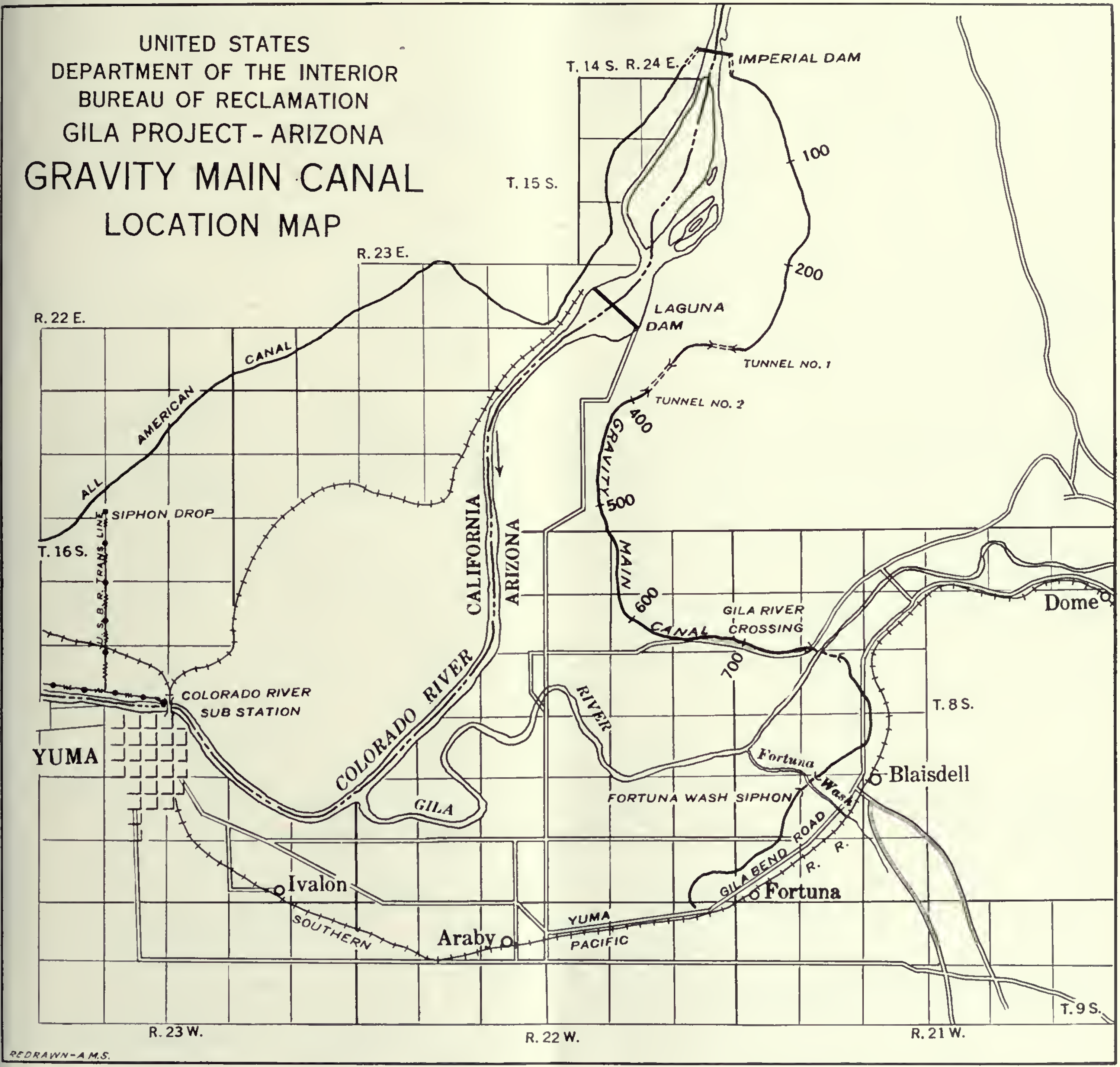
The ground water in the bed of the river presented a unique problem. Evidence showed the water table to be either at or very near the surface, but the underground flow was unknown, though from the fact that it drains from such an extensive area much of which is under irrigation, it was considered to be quite large. The ground in which the siphon is built is entirely sand, ranging from blow sand and silt to a fairly coarse sand with small lenses of clay and gravel. No previous data from pumping operations in this vicinity were available, and experience from foundation unwatering at Imperial Dam, where conditions were apparently somewhat similar, indicated that large quantities of water would have to be pumped in order to overcome a low resistance of the material.

Preliminary studies showed that the foundation for nearly the entire length of the siphon barrel would have to be unwatered. Before the work was started, it was thought that a well-point system would be the safest means for unwatering the area. Against this method, however, was the cost, both of equipment and operation, and the actual job cost of moving the points ahead with risk of delay to the work; and under a concrete placing program which required that 700 feet of trench be opened and unwatered at once, it would have required two lifts of well points along 200 or 300 feet of the trench at the deepest point. This plan was discarded as uneconomical for such a system would have required the procurement and operation of a great deal of costly equipment.

A system of deep wells and pumps was finally adopted, and three wells were put down at distances of 1,020, 1,410, and 1,685 feet from the inlet portal along the top edge of the excavation approximately 50 feet downstream (in the river) from the transverse center of the structure. The wells were to unwater the area between approximately the longitudinal center of the siphon and the outlet end. These were driven through 65 feet of sand and 30 feet of gravel, and the casings were perforated for 20 feet at the bottom to develop a flow of 2,000 gallons per minute. The well nearest the inlet was originally driven only 15 feet into the gravel, and the casing perforated for only 11 feet. However, the gravel encountered was too fine to yield a satisfactory flow, and it was necessary to drill deeper inside the casing and perforate an additional 20 feet of new small casing to obtain the desired result. Except in this instance, no trouble was had in developing the wells to a flow of 2,000 gallons per minute.

In order to determine the action of the ground water under continued pumping and the number of pumps that might be required, concrete placing was started at the outlet end of the siphon where the water had to be lowered the least. The profile of the siphon lent itself admirably to this procedure, as from the vertical angle point near the center of the barrel, to the deepest point under the main channel, the gentle grade of the structure permitted the water to be lowered gradually, thereby allowing that area to receive the full benefit of continued pumping.

Pumping from the first three wells accomplished a maximum draw-down of nearly 12 feet over the entire distance between the end wells. The hydraulic gradient away from the end wells was 1 to 1½ percent. A fourth well was subsequently drilled in this division of the work 1,560 feet from the inlet to provide



pumping facilities in case of failure in one of the other pumps and to assure ample capacity. These wells were sufficient to unwater the foundations for the last half of the siphon.

In the main channel of the river where the lowest point in the excavation was reached, a maximum draw-down of more than 20 feet was required which was much greater than that obtained with the pumps spaced so far apart as the first three. To accomplish this, two wells only 75 feet apart were drilled at distances of 385 and 460 feet from the inlet, near the low point of the siphon. These wells were to develop the maximum flow of the strata, and effected the required draw-down without difficulty. A condition that aided the wells in this location was the fact that the flow from one side was cut off by the rock hills that formed the right side of the canyon.

A third well was installed 500 feet from the inlet, approximately 75 feet from the other two, to serve as a stand-by or to be used in case additional capacity was required. It was never pumped, however.

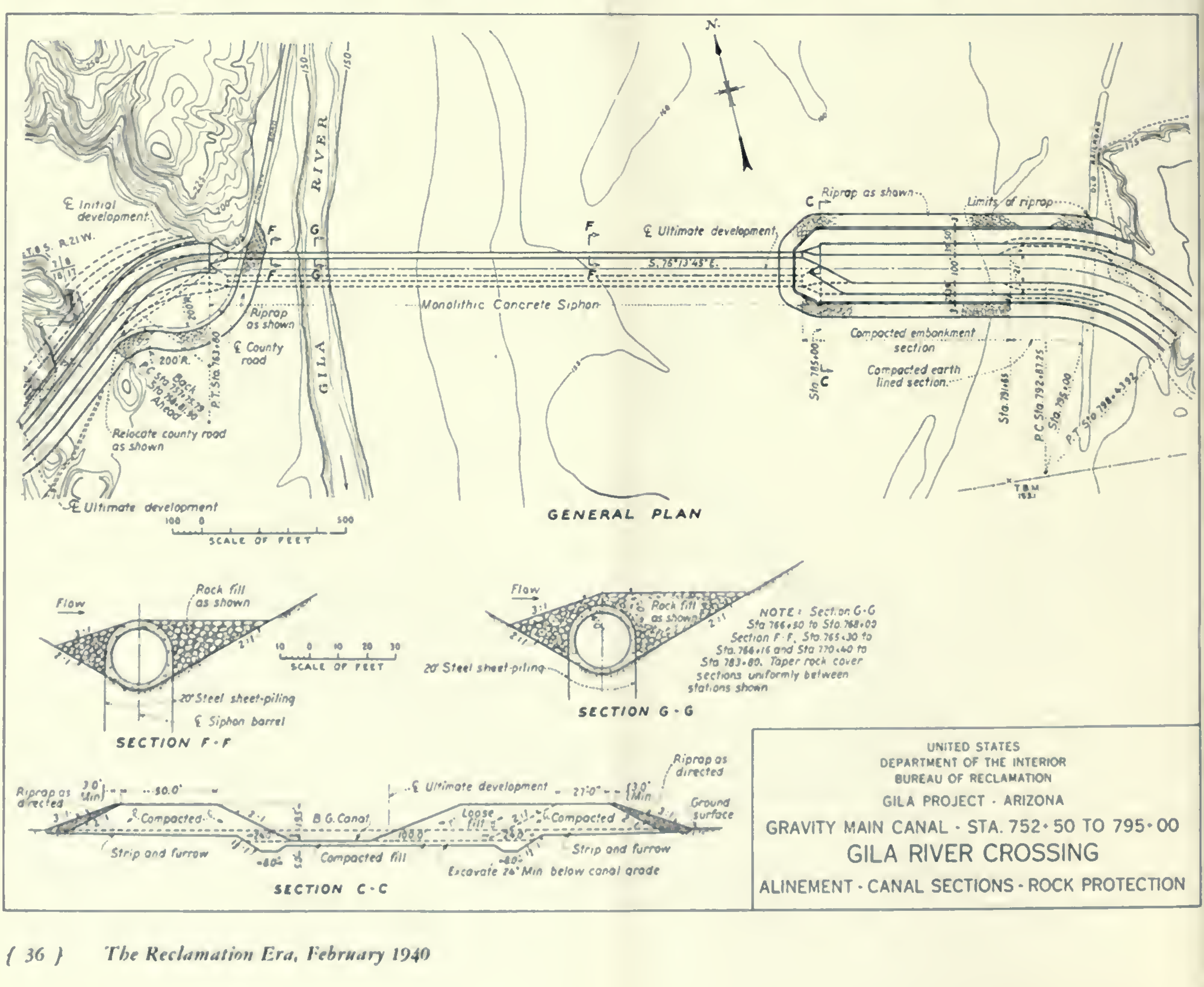
During the pumping period, three pumps were usually in service at one time, although four were used occasionally. The quantity of water pumped varied from 4,000 to 6,000 gallons per minute. The pumps were deep-well turbines with 40 horsepower motors and No. 3 kilowatt-hour, single-stage, high head impellers. The pumps had 10-inch columns 47 feet 6 inches long and an 8-inch discharge, and were rated by the manufacturer at a capacity of approximately 2,000 gallons per minute for the head under which they operated.

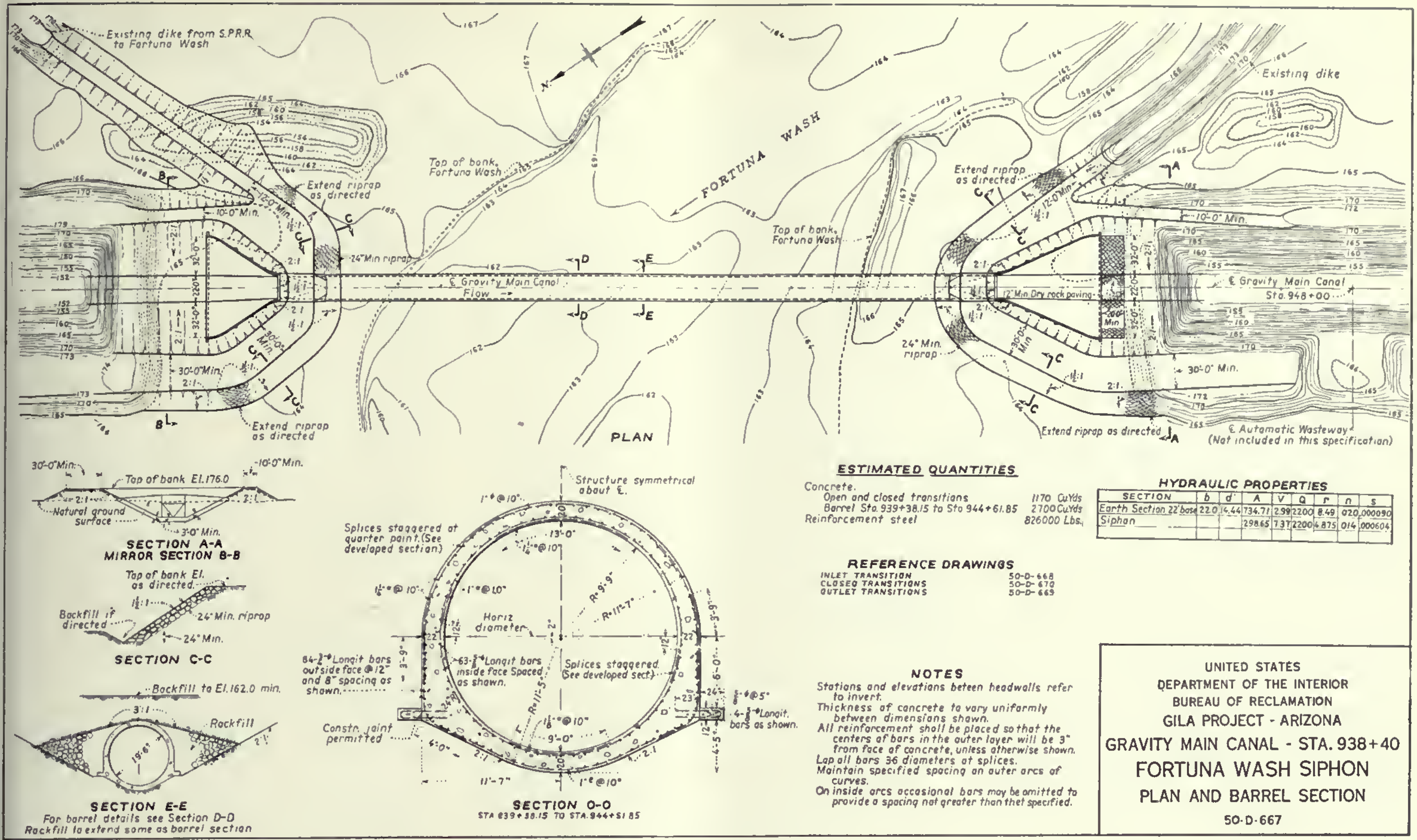
In adopting this method for unwatering the foundations, the hazard lay, therefore, in the nature of the pervious strata underlying the work. Had this been an extremely coarse material, a great deal more pumping would have had to be done. Indeed, this strata might have been so coarse and the inflow so heavy that unwatering by this method would have been impracticable. It is also true this method requires the handling of a comparatively large volume of water much larger than would have been handled by a well-point system working entirely in sand.

As results proved, the method used was entirely successful. At no time was there any difficulty in keeping the water at the required depth below the foundations, and it was considerably cheaper in ultimate cost than any other method which might have been used.

Fortuna Siphon

The siphon under Fortuna Wash is a single-barrel structure, similar in design and construction to the Gila River Crossing, except that a gate structure was not provided and the various sections have been modified in accordance with the particular requirements. Being on a reach of the Gravity Main Canal which will not be enlarged by future developments, the structure is complete. Since there were no foundations or other advantages to be gained on either side of the wash, the structure was placed centrally under the water course, which at this point, is broad with very slight concavity. As a result of the latter condition, the barrel is straight


N.
GILA RIVER
℄ Initial development
℄ Ultimate development
Riprap as shown
℄ County road
200'R.
Relocate county road as shown
S. 76°13'45" E.
Monolithic Concrete Siphon
Limits of riprap
Compacted embankment section
Compacted earth lined section
Sta. 785+00
GENERAL PLAN
SCALE OF FEET
Flow
Rock fill as shown
20' Steel sheet-piling
℄ Siphon barrel
SECTION F-F
SECTION G-G
NOTE: Section G-G Sta. 766+50 to Sta. 768+00. Section F-F, Sta. 765+30 to Sta. 766+16 and Sta. 770+40 to Sta. 783+80. Taper rock cover sections uniformly between stations shown
Riprap as directed
Compacted
B.G. Canal
Loose fill
Strip and furrow
Compacted fill
Excavate 24" Min. below canal grade
Ground surface
SECTION C-C
UNITED STATES
DEPARTMENT OF THE INTERIOR
BUREAU OF RECLAMATION
GILA PROJECT - ARIZONA
GRAVITY MAIN CANAL - STA. 752+50 TO 795+00
GILA RIVER CROSSING
ALINEMENT - CANAL SECTIONS - ROCK PROTECTION


Existing dike from S.P.R.R. to Fortuna Wash
Existing dike
FORTUNA WASH
Top of bank, Fortuna Wash
Extend riprap as directed
24" Min riprap
℄ Gravity Main Canal
Flow
℄ Gravity Main Canal Sta. 948+00
12" Min Dry rock paving
30'-0" Min.
10'-0" Min.
24" Min. riprap
Extend riprap as directed
℄ Automatic Wasteway (Not included in this specification)
PLAN
Top of bank El. 176.0
Natural ground surface
SECTION A-A
MIRROR SECTION B-B
Top of bank El. as directed
Backfill if directed
24" Min. riprap
SECTION C-C
Backfill to El. 162.0 min.
Rockfill
SECTION E-E
For barrel details see Section D-D
Rockfill to extend same as barrel section
Structure symmetrical about ℄.
Splices staggered at quarter point. (See developed section)
Horiz diameter
Splices staggered (See developed sect.)
Constr. joint permitted
SECTION D-D
STA. 939+38.15 TO STA. 944+61.85
ESTIMATED QUANTITIES
Concrete.
Open and closed transitions 1170 CuYds
Barrel Sta. 939+38.15 to Sta 944+61.85 2700 CuYds
Reinforcement steel 826000 Lbs.
REFERENCE DRAWINGS
INLET TRANSITION 50-D-668
CLOSED TRANSITIONS 50-D-670
OUTLET TRANSITIONS 50-D-669
HYDRAULIC PROPERTIES
SECTION b d A V Q r n s
Earth Section 22' base 22.0 14.44 734.71 2.99 2200 8.49 .020 .000090
Siphon 298.65 7.37 2200 4.875 .014 .000604
NOTES
Stations and elevations beteen headwalls refer to invert.
Thickness of concrete to vary uniformly between dimensions shown.
All reinforcement shall be placed so that the centers of bars in the outer layer will be 3" from face of concrete, unless otherwise shown.
Lap all bars 36 diameters at splices.
Maintain specified spacing on outer arcs of curves.
On inside arcs occasional bars may be omitted to provide a spacing not greater than thet specified.
UNITED STATES
DEPARTMENT OF THE INTERIOR
BUREAU OF RECLAMATION
GILA PROJECT - ARIZONA
GRAVITY MAIN CANAL - STA. 938+40
FORTUNA WASH SIPHON
PLAN AND BARREL SECTION
50-D-667

without grade between the vertical curves adjacent to the closed transitions.

The length between the ends of the closed transitions is 600 feet, to which the open inlet and outlet transitions add 60 and 88 feet, respectively. The open transitions are symmetrical in respect to the centerline, with warped walls on both sides. Both closed transitions are of the same dimensions as for the Gila Siphon, except for the variations due to the steeper grades. The barrel section throughout is the same as the lighter section of the first barrel with the addition of a 1- by 2-foot bearing projection on each side of the barrel at the lower edge. Since the wash course normally has no ground water flow within a proximity of the structure, and since the storm flows are of relatively short duration, the steel sheet piling cut-off walls were eliminated and the rockfill around the barrel was lightened by placing the material on both sides to 3 : 1 slopes below the top. Both embankments surrounding the structures at the inlet and outlet ends and joining the canal sections are common fills having a top width of 30 feet with slopes of 1½ : 1 on the outside and 2 : 1 in the canal section. Above the canal, the fills project at approximately 40° from the centerline to the embankment of the Southern Pacific Railroad, thereby forming continuous training dikes to control the flows past the siphon. The outside slopes are covered with blankets of riprap 3 feet wide at the top and varying between slopes of 1½ : 1 on the embankment to 2½ : 1 at the surface.

Construction at Fortuna Siphon followed closely the methods worked out for the Gila Crossing. The same contractor's organization performed the work, and therefore used the same plant and equipment. An outstanding advantage of such a method was the similarity in the sections of the siphon barrels permitting the same forms to be used for both structures. With no ground water to control and no piling to drive, and due to the fact that concrete was all placed during a season of the year when weather temperatures were most favorable, a greatly increased rate of progress was realized.

The siphons were constructed under separate contracts and specifications though the principals of the two contracting companies were the same and directed all operations. The Gila River Crossing, under Specifications No. 740, was awarded to the Metropolitan Construction Co., Los Angeles, Calif. Fortuna Siphon was one of two structures in Schedule No. 3 of Specifications No. 800, awarded to the Jahn and Bressi Construction Co., Inc., Los Angeles, Calif.

Notable Visitors to Southwestern Projects

ON a recent Saturday in December the All-American Canal and Gila projects were hosts to two notable groups of visitors. More than 100 mayors, aldermen, councilmen, engineers, and legal advisors, representing every incorporated city and town in Arizona, were conducted over the two projects now under construction. They were also shown the irrigated sections of the Gila and Yuma Valleys. The executives were in Yuma to attend the annual midwinter convention of the Arizona Municipal League.

On the same day, approximately 100 school teachers in annual convention at El Centro, Calif., were conducted over the All-American Canal and headworks and the Imperial and Laguna Dams.

Both groups expressed pleasure at the opportunity for viewing at first hand, the work being performed by the Bureau in this territory.

Walter I. Swanton Honored

Mr. Swanton, a member of the Engineering Division of the Washington office, was elected supervisor of the District of Columbia Society of Professional Engineers at the annual meeting.

City Manager Ely Bereaved

Mr. Sims Ely, city manager of Boulder City, Nev., suffered the loss of his wife early Sunday morning, January 7. She died at the Las Vegas hospital. Mr. Ely was at her side.

The Effect of Shasta Dam on Navigation and Flood Control

By MAJ. F. M. S. JOHNSON, *Corps of Engineers, War Department, San Francisco*

THE valley floor from Redding to the mouth of the Sacramento River is about 200 miles long, 25 miles average width, and has an area exceeding 5,000 square miles. The discovery of gold in the tailrace of General Sutter's sawmill at Coloma on the South Fork of the American River on January 24, 1848, started the settlement of the Sacramento Valley. Towns were established at favorable locations along the streams and, since land travel was too slow and difficult for the impatient multitude, every available boat at San Francisco was pressed into service for the trip up the Sacramento River. The gold-hungry horde from the coastal settlements soon was swelled by fortune seekers from all parts of the world. Ocean-going steamers that came around Cape Horn to San Francisco continued on to Sacramento about 125 miles upstream, and some even went up the Feather River as far as Marysville, 60 miles above Sacramento. By the spring of 1849 the rush had become so great that profits to be obtained from river commerce assumed the proportions of a separate bonanza.

During the decade of 1850–60 several companies operated year-round service between San Francisco and Sacramento, and the two best known boats drew 13 feet of water. Freight and passenger boats of lesser depth operated regularly to Marysville and Red Bluff. Operations of the hydraulic mines of the Sierra-Nevada virtually put an end to regular navigation of the Sacramento River above Sacramento. Hydraulic mining was begun on tributaries of the Sacramento River in 1856. The first obstruction to navigation due to mining was noted following the unprecedented floods of 1862 which carried an enormous volume of debris from the mountains into the valley. Shoals rapidly formed. Channels were fouled and boat landings isolated by sand bars. The millions of cubic yards of debris dumped into the streams continued to move down the river for many years after hydraulic mining was restricted by the courts in 1884.

Around 1890 the controlling depth from the mouth of the river to Sacramento was 4 feet, from Sacramento to Colusa the depth was a little over 3 feet. Between Colusa and Red Bluff nests of snags nearly blocked the river, and the controlling depth at low water was less than 3 feet below Chico Landing and less than 1 foot above that place. River widths above Sacramento range from 250 to 350 feet and there are many bends, especially in the upper reaches. Between Sacramento and Colusa the fall at low water is about 0.4 feet per mile; between Colusa and Chico Landing 1.4 feet per mile; and between Chico Landing and Red Bluff, 2.4 feet per mile.

The existing navigation project provides for a channel 10 feet deep at mean lower low water and 150 to 200 feet wide from the mouth to Sacramento, thence 4 feet deep at low water to Colusa; 3 feet deep at low water to Chico Landing and such depths as may be practicable from there to Red Bluff, the head of navigation. Project depth has been secured in the new 10-foot channel to Sacramento by means of wing dams, supplemented by dredging, and this channel as a whole is now practically completed.

Owing to diversions for irrigation and to the low natural flow, project depths are not maintained at present in low-water periods above Sacramento. During the high-water period from December to May considerably better than project depths usually exist, and boats drawing 4 feet can be taken to Red Bluff.

Wing dams have been built and maintained at practically all shoals above Sacramento to the mouth of the Feather River, but navigation has in dry years been suspended entirely from about the middle of June to the middle of September.

Below Sacramento the existing project depth of 10 feet has heretofore been considered adequate for present and reasonably prospective commerce, but recently demands have been made by shipping interests, for a channel 30 feet deep and 43 miles long from the mouth of the river at Collinsville to Sacramento in order to provide continuation and extension of base terminal rates at Sacramento, and also to accommodate ocean steamers.

River Improvement

The portion of the river from Sacramento to Chico Landing is particularly worthy of further improvement. Above Chico Landing the channel is so steep and crooked that the cost of improvement would be too high and returns from commerce of the area too low to justify any substantial expenditure.

Studies indicate that Shasta Dam can be operated during average seasons to maintain a depth of 6 feet to Chico Landing, based upon a minimum flow of 5,000 second-feet. During extreme dry cycles, however, such as occurred from 1930 to 1935, it is doubtful if such a flow would be maintained, and traffic might be interrupted for perhaps 3 months each season, unless the river was canalized.

River Canalization

Canalization of 141 miles of the river between Sacramento and Chico Landing would require the construction of 6 locks and movable dams with lifts aggregating 112 feet in height. Lock dimensions 56 by 360 feet in the clear are considered. The cost was estimated in 1932 to be $7,400,000, including the necessary levees and dredging. From Chico Landing to Red Bluff the distance is 53 miles and the lift 125 feet. The cost of canalizing this section was estimated at $7,500,000.

More than 500,000 tons of agricultural commodities are shipped from the upper Sacramento Basin each year, with barley and rice predominating. Most of this tonnage would probably move by boat if navigation could be made dependable.

Between the mouth of the river and Sacramento, excluding Rio Vista, there are 17 large wharves, 36 large warehouses, and many small warehouses and landings. At Rio Vista there are 1,440 linear feet of wharf and warehouse facilities. There are 15 piers and wharves on both sides of the river at Sacramento, which have a combined actual berthing space of 3,520 linear feet, serving 200,000 square feet of transit shed area. To facilitate the handling of freight, the more important transit sheds are provided with electric freight elevators.

Navigation

Between Sacramento and Chico Landing there are no large wharves, but numerous small landings are maintained and freight is also handled directly from the banks. With a minimum flow of 5,000 second-feet provided by Shasta Dam releases, it is believed that a 6-foot channel depth can be maintained to Chico Landing, and some reduction in the cost of maintaining the 10-foot project depth below Sacramento will be effected. The economic value of further improvements is measured by savings in costs of transportation that can be effected thereby.

In considering the importance of river navigation and the benefits to be derived therefrom, one should note the strategic location of the river in relation to the markets and centers of trade. This valley is surrounded by mountains on all sides, which causes the major portion of trade to go through the seaports of the San Francisco Bay region. The Sacramento River forms a direct transportation artery to these points and passes through the main valley trading center, Sacramento. It is also to be noted that major crops of the Sacramento Valley—rice, barley, and fruits—are shipped in large quantities from the port of San Francisco on ocean-going vessels. An improved condition of the Sacramento River would allow these products to be carried for distances upward to 250 miles by water to San Francisco and allow delivery direct to ocean terminal facilities.

Between Redding and the mouth of the Sacramento River there are about 3,000,000 acres of farm land in the valley floor of which about 65 percent is now used for crops which include about 650,000 acres of irrigated land. Agriculture, mining, and manufacturing constitute the principal income-producing activities within the valley. The approximate gross income from these activities for 1930 for the entire Sacramento Valley was $270,000,000.

The following estimates of navigation benefits are based upon a depth of 6 feet to Chico Landing, which would permit boats of 5-foot draft.

Tonnage from the tributary area moving parallel to the river above Sacramento in 1930 was about 750,000 tons. With minimum channel depths of 6 feet as planned with Shasta Dam operating, it has been estimated that the average annual saving from navigation would be $300,000. The estimated cost of channel maintenance above Sacramento is $55,000, so the net annual saving would be $300,000—$55,000=$245,000 which, capitalized at 3½ percent, yields $7,000,000, the amount which could be profitably contributed to the cost of Shasta Dam for navigation.

Although the Sacramento today is potentially one of the Nation's most important inland waterways, regular year-round navigation is still largely confined to the section of the river below Sacramento, pending further improvement in the upstream channel and seasonal regulation of flow of the river by Shasta Reservoir.

Flood Control

Shasta Dam will benefit flood control in addition to navigation. Records of floods in the Sacramento River area go back to 1805 which formed an epoch in Indian history. The flood of 1825–26 was outstanding in the memories of the natives, and that of 1850 lived in the memories of early white settlers as a frightful visitation to the pioneer towns. The city of Sacramento was flooded in 1850, 1852–53, and 1862. In the last-named flood it is related the entire Central Valley was inundated and river boats went overland to Stockton, rescuing stranded people from the ranches along the way.

The population of the valley constantly increased and agriculture became more and more its leading industry. With rapid and extensive settlement of the rural areas, cities and towns sprang up and important income-producing activities in addition to agriculture developed. These greatly increased the general and individual flood hazards and it became obvious that the continued prosperity and development of the valley, as well as the safety of its inhabitants, required a comprehensive, coordinated, and adequate system of flood-control works. The debris from gold-mining operations washed down by flood waters covered large agricultural areas and damage from floods was greatly increased.

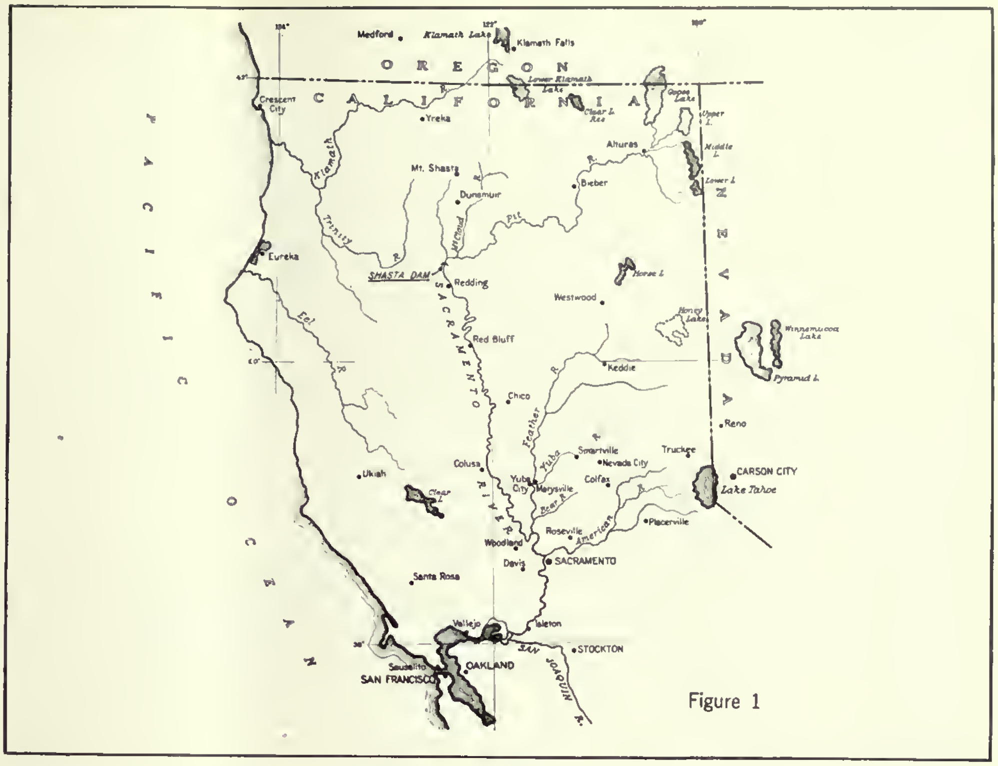


Figure 1

Operation of California Debris Commission

In 1893 by the Caminetti Act, Congress created the California Debris Commission with authority to regulate hydraulic mining operations, improve and maintain the navigability of rivers, and prepare a flood-control plan.

Previous to the creation of the California Debris Commission various plans for a comprehensive system of flood control works had been proposed based on maximum flood discharges as low as 250,000 second-feet. The floods of 1907–9 showed that any project to be reasonably protective would have to provide for a maximum discharge of about 600,000 second-feet below Sacramento.

The Debris Commission's report of 1910 proposed a plan for flood control in the Sacramento Valley essentially similar to the existing project now under construction. The main features of the plan are shown on figure 2, which is schematic. It provides for levees along the Sacramento River channel and leveed bypasses through Sutter and Yolo Basins of width sufficient for passage of floods. Relief bypasses at various points permit water to escape from the river channel into the bypasses. When the flood discharge exceeds the normal capacity of the river along Butte Basin, water overflows into the basin through natural overflow channels at the upper end and Moulton Weir (500-foot crest) and Colusa Weir (1,650-foot crest) farther downstream. After making its way downstream through the fields of Butte Basin, the overflow waters are concentrated into the Sutter bypass, which is 4,000 feet wide at the upper end, between levees 18 to 20 feet high, with a capacity of 216,000 second-feet, and 5-foot freeboard. Further relief for the river is afforded by Tisdale Weir (1,155-foot crest) which is provided with a well-leveed bypass diverting water to Sutter bypass.

Below the mouth of Feather River, Sutter bypass increases in width to 7 000 feet and in capacity to 416,000 second-feet. At Fremont Weir (9,120-foot crest) the excess waters cross the river channel and enter the Yolo bypass, which is 8,000 to 13,000 feet wide in the portions having levees on each side, and much wider in the low reaches. Levees range in height from 15 to 20 feet with 6 feet freeboard. The capacity at the upper end is 343,000 second-feet and 500,000 second-feet at the lower end.

Sacramento Weir and Bypass

An interesting feature of the plan is the Sacramento Weir (1,900-foot crest) and bypass, which transports American river flood waters to the Yolo bypass. Direction of flow in the Sacramento River between the mouth of the American River and Sacramento Weir is reversed when floodwaters from the American make it necessary to open the gates on Sacramento Weir while the flow from the upper river is comparatively low. Sacramento is the only one of the weirs having gates. All the weirs are made of concrete and serve the purpose of confining the river to its main channel and preventing overflow into the bypasses until the river reaches dangerous stages.

The Debris Commission's proposed plan, with minor changes, was adopted by the State in 1911 and the Federal Government by the Flood Control Act of March 1, 1917. The project is now about 85 percent completed and the total estimated cost is $51,000,000, exclusive of costs of right-of-way. Under the revised plan, the Federal Government contributes $17,600,000, the remainder of the cost being provided by the State of California and local interests. Although the bypass plan handles floods in a satisfactory manner from the lower end of Butte Basin downstream, considerable annual damage continues to be inflicted on the upper areas.

The project was designed with the assumption that the area known as Butte Basin might at some future time be reclaimed and flood waters carried through it in a leveed channel leading from a point near Butte City to the upper end of the Sutter bypass. At the present time this basin is open so that floods exceeding the capacity of the river channel alongside, overflow into the basin and are carried off through the Sutter bypass. For a project flood the storage capacity of the basin is estimated to be 700,000 acre-feet which has an important effect on floods from the upper Sacramento River. About 130,000 acres in the Basin could be reclaimed, but much of the land is now in pasture, which is not damaged extensively by floods. Estimates indicate that flood flows through Butte Basin will be reduced substantially by Shasta Reservoir storage, thus making it possible to confine the flow to the river as far as Colusa.

In the 1937 flood it is estimated that $213,000 damage was done in Butte Basin by natural overflow and that the flood peak was reduced roughly 110,000 cubic feet per second. Shasta Dam could have reduced the flow by about the same amount without the aid of Butte Basin storage and hence would give about the same degree of protection below as now exists.

If these lands could be utilized safely for intensive farming, benefits from flood control of Shasta Dam would be greatly augmented. If the flood control project were to be utilized to capacity, it has been estimated that 500,000 acre-feet of flood control storage at Shasta would reduce flood peaks 30 percent or more at the head of Butte Basin. The degree of reduction of the flow below Butte Basin would depend on characteristics of the flood and cannot be determined with any degree of accuracy. Obviously it would decrease as the crest moves downstream and if the Sacramento River crest coincided with those of the Feather and American Rivers, it probably would be less than 15 percent at Sacramento. The major portion of the run-off occurs between December and April. As most of the drainage area, 9,258 square miles in extent above Red Bluff lies below the elevation at which snow is deposited, the run-off during the winter period is characterized by high peak flows of short duration, usually only a few days. The snow deposited at the higher elevations during the winter usually melts during April and May resulting in a substantial run-off at fairly uniform rates during these months. By June most of the snow has vanished and the river has to depend almost entirely on ground storage for its supply. It can be seen that even in a year like 1909, one of the wettest of record, the discharge of the upper Sacramento dropped to about 6,000 cubic feet per second and in an extremely dry year such as 1931, the river flow was only about 3,000 cubic feet per second. Of these flows about 2,000 cubic feet per second is withdrawn by irrigation on the upper river so that the amount of water remaining in the river between June and November is usually between 1,000 and 4,000 cubic feet per second.

The flood of 1909 closely approximates the project design storm. Nineteen thirty-one shows a very dry year. (Indian legend records a year in which not a drop of rain fell in the Central Valley.) The flood of December 1937, was typical in many respects of those of major magnitude, produced by winter storms that occur in the Sacramento Valley and as it was of recent occurrence, more data are available concerning it than of previous floods. On the morning of December 10, 1937, the weather map showed a storm of record magnitude, and almost hurricane intensity off the coast of Washington and Oregon. Tropical air from the Pacific Ocean was racing across California at gale velocity and impinging against the high mountain barriers that form the eastern and northern limits of the Sacramento drainage basin. Moisture laden air approximating a record high temperature for December prevailed, and as a result rainfall was torrential, reaching cloudburst proportions over the headwaters of many of the streams. The storm was one of the most intense ever experienced in this region. In the 2-day period, December 10-11, rainfall in excess of 18 inches fell in places. The greatest 24-hour fall reported was 11½ inches.

About 48 hours after the beginning of the rain, the flood waters had practically reached the Sacramento River and a flood wave began moving down that stream, which crested at Shasta Dam at 2 a. m., December 11, Red Bluff at 8:35 a. m., and at Sidds Landing at 5 p. m. the same day, where it totaled 310,000 second-feet. The crest reached Butte City at 7:30 a. m. on December 12 and arrived at the Fremont Weir from both the Sacramento and Sutter bypass at 4:25 a. m. December 14.

Shasta Dam from left abutment roadway, showing operations on right abutment, Powerhouse and penstock areas, abutment excavation, cableway headtower, and a portion of the stock pile area

The Feather River crest had passed Fremont Weir on December 12, and on the American River the flood crest had gone by Sacramento ahead of the upriver crests. This was a fortunate condition for while Sacramento and adjacent communities appear to be adequately protected by the existing projects works against floods such as have occurred in the past, a simultaneous cresting of the largest discharges would certainly tax to the utmost the present capacities of the project protection works.

Within the city limits of Sacramento most of the area is below the levees, and in the event these failed the city would be submerged to a depth of 11 to 15 feet. Both Washington and North Sacramento adjoining substantial urban communities on the north banks of the Sacramento and American Rivers, respectively, are built on similar low ground and subject to the same flood menace that threatens Sacramento.

Expressed in monetary values, the physical damage that could result from a major flood causing inundation of rural areas within the existing project protection works and which at the same time flooded the cities of Sacramento and North Sacramento, is estimated to be $47,000,000.

Shasta Dam would in most floods supersede the work already being done by Butte Basin, but in extreme floods both reservoirs would be used to capacity giving increased flood protection to downstream points. The benefit of Shasta Dam on points below Butte Basin, with the basin operating as at present, is insignificant except in extreme cases of frequency of about once in 100 years, at which time it might result in eliminating flood damage amounting to millions of dollars caused by levee failures or overtopping.

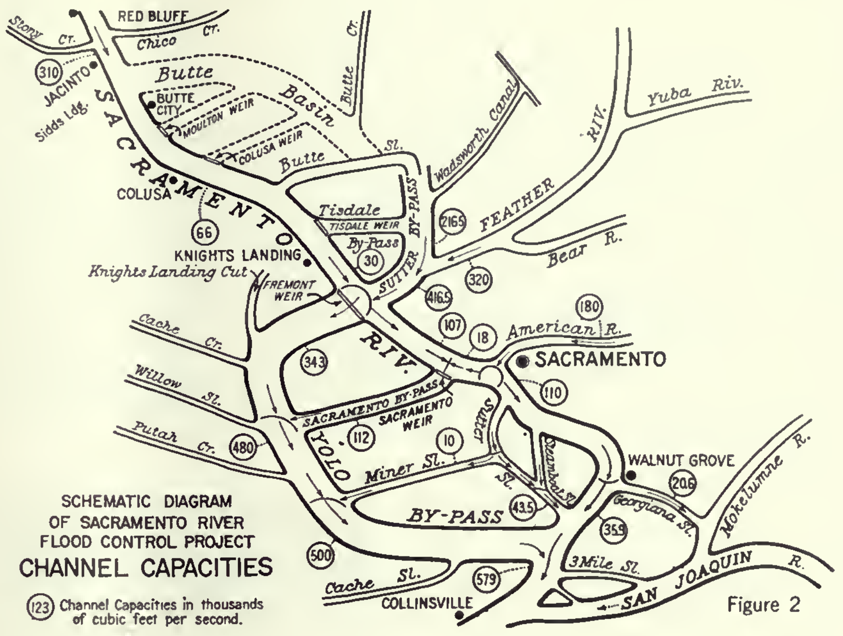
Shasta Flood-Control Benefits

The average annual flood control benefits of Shasta Reservoir have been established as follows:

Annual benefits below Chico Landing	$164, 000
Annual benefits above Chico Landing	7, 000
Total annual benefits	171, 000

The total amount evaluated for flood control at 3½ percent equals $4,886,000.

By remedying the intrusion of salt water into the delta of the Sacramento and San Joaquin Rivers, Shasta Dam eliminates from consideration Federal participation in the construction and operation at great cost of locks and structures to prevent such intrusion. Based on this aspect of the case, as well as the direct benefits to navigation and flood control on the Sacramento River, general and Federal benefits from the construction of the Shasta Dam warrant a special direct participation of the War Department of $12,000,000 in the cost of the structure.



SCHEMATIC DIAGRAM
OF SACRAMENTO RIVER
FLOOD CONTROL PROJECT
CHANNEL CAPACITIES

Figure 2

The Nation's First Census of Housing

A COMPREHENSIVE picture of housing and home ownership in the United States will be compiled from information to be gathered by the 120,000 census enumerators in conjunction with the sixteenth decennial census to be conducted by the United States Bureau of the Census in April. Data—in response to a schedule of 31 questions bearing on the type of structure, equipment, and ownership—will be obtained for each of the approximately 35,000,000 dwellings throughout the country.

Housing experts point out that the information gathered will be of inestimable value in the determination of future housing policies. It will be of especial interest to manufacturers, builders, distributors, and bankers in their study of trends in home ownership and building in the United States. Census authorities explain that through their tabulations it will be possible to determine facts of vital importance to local geographical and political subdivisions. For example, cities will be able to determine the distribution of the various types of housing within their limits, together with the possible need of expansion of transportation and communication systems, police and fire protection, schools, and similar facilities.

The tables will also help social workers to establish relationships between certain types of housing and human needs by correlating their own data on characteristics and locations of clients with the census information on characteristics of the homes.

Data showing the equipment in homes, together with the state of repair of the homes, will be of value to manufacturers and distributors of housing products in the planning of their sales campaigns.

Home finance institutions will find the average amount of mortgage and the data on mortgages of value in proving and checking the soundness of their investments and the possibility of mortgage expansion.

The aid of trade associations, financial groups, and research organizations was obtained by census officials in the preparation of the questions. In this manner the authorities feel they have arrived at a group of questions which will gather the greatest possible amount of useful information.

The housing census will be made at the same time as the balance of the decennial census and will be made by the same workers. Authority for the housing census was voted by Congress at its last session. Action on the appropriation has been deferred until the 1940 session.

Questions To Be Asked

The questions to be asked by the enumerators in connection with the housing phase of the census have been tentatively set up under the following heads:

1. Characteristics of structure in which dwelling unit is located.
2. Characteristics of dwelling unit.
3. Characteristics of occupied dwelling unit.
4. Mortgage characteristics of owner-occupied nonfarm 1- to 4-family structure.

Monuments to the Living

By WALTER K. M. SLAVIK

RECLAMATION engineers build big. In November 1939 with the beginning of construction on Friant Dam in California's San Joaquin Valley, they brought to five the number of masonry dams in this country which remain unsurpassed in size throughout the rest of the world.

The most massive dam of all is Grand Coulee Dam in Washington, described as the "biggest thing on earth." Second in size is Shasta Dam in the Sacramento Valley, Calif. Third is Boulder Dam, which is further distinguished by being the highest dam, bar none, in the entire world. Fourth is Friant, and fifth is Marshall Ford Dam on the Colorado River in Texas.

To repeat, these five dams account for the five largest concrete dams in the world, all in the United States, and all built or under construction by the Bureau of Reclamation.

This huge construction in our country is something of a remarkable fact, remarkable enough, at least, to draw the attention of contemporary writers of such note as Garet Garrett, and to be featured in such an outstanding magazine as *The Saturday Evening Post.*

Marveling at the size and grandeur of Reclamation works, Mr. Garrett postulated that when there was a surplus of food, labor, materials, and money, the conditions were ripe for the monumental phase of a civilization. Such conditions were present in the United States, Mr. Garrett maintained, and we are building the things that will stand like the Pyramids of Egypt a thousand years after perhaps all else is gone.

Other commentators have advanced the theory that in the United States we outbuild all the rest of the world because the country itself is so big. Many needs must be satisfied, therefore of necessity our works must be greater.

Whatever the interpretation, it should be borne in mind that no matter how big, our storage dams are only parts of a larger work—the irrigation project—and that they represent a comparatively recent development in irrigation, the practice of which is so old that it antedates mankind's written history.

Sine Qua Non *of Civilization*

Not until men discovered that irrigation could produce more food from the earth than they got by the nomadic huntsman's life did they settle down to civilization in such garden spots as the Nile and the Tigris and Euphrates Valleys, and, later, start a written record of their activities.

Irrigation can thus be called the *sine qua non* of civilization. Without the natural irrigation resulting from the annual floods of the Nile and other rivers in Babylonia, India, and China, mankind might never have clustered in great communities and so quickly produced the high social organization and splendid cultures of these ancient races.

In 2000 B. C. the Egyptians already practiced a primitive artificial irrigation to supplement the natural one of the Nile. Records are extant which show the use of the shadoof at this early date. The shadoof consisted of a receptacle hung from one end of a long pole set on a cross beam; at the other end of the pole was a counterpoise. With the shadoof it was possible to bail water from the Nile River to adjacent fields. Many slaves working from morning to night could irrigate as many as 4 acres.

Boulder Dam, Boulder Canyon Project, Arizona-Nevada

From Man Power to Machinery

The next step forward in artificial irrigation was the sakia, which consisted of a rude wooden waterwheel with earthen pots on an endless chain. By this improved method a pair of oxen could irrigate as many as 12 acres, three times as much as by manpower.

In the meantime, also, the Egyptians had begun to erect levees and dikes along the river's course, and had learned to breach the dikes in flood time whenever they wished to let 3 or 4 feet of water flow over their flat fields. Still later, they breached dikes to let the water flow into canals which they had constructed, to irrigate fields still farther from the Nile's banks.

But as ancient as the practice of irrigation was—"And a river went out of Eden to water the garden," says Genesis 11 : 10—it was a long time before the Egyptians got around to the idea of using dams. When they finally did, the dams they built were as little like our modern storage dams as the Roman chariot our present-day automobile. They were primitive earthen structures, check dams which merely lifted the river water a few feet to fill the canals above the dam, to irrigate fields otherwise beyond reach. Not until the twentieth century, in fact, did the Egyptians construct a true dam, one which was able to store water in times of plenty for use in days of scarcity. And curiously enough, they had all along an example of a natural storage reservoir in their own land—for in the Fayoum, in Upper Egypt, was Lake Moeris, which filled during the annual Nile flood and then was drawn upon later for a supply of irrigation water, as needed.

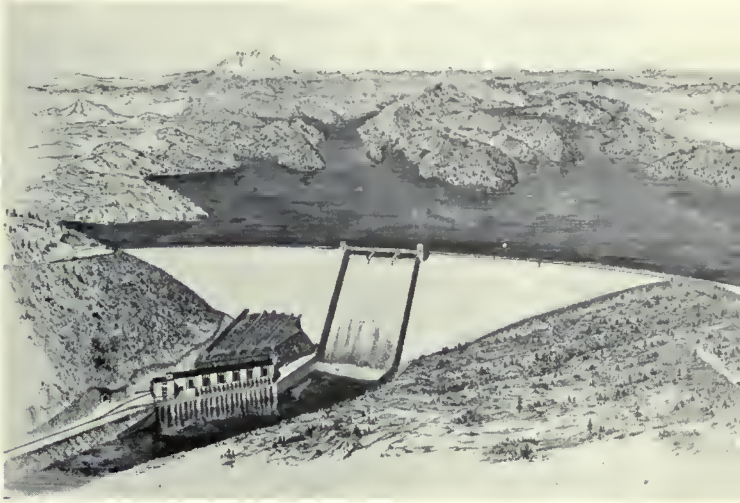
Egypt did not even build a sizable check dam until as late as 1861 when it employed a French engineer named Mougel Bey to attempt a structure at the apex of the Nile delta about 12 miles north of Cairo. The attempt failed; the dam cracked so badly it was soon useless. Finally, in 1902, the present Assuan Dam was completed, Egypt's first true storage dam.

In the Jungles of Ceylon

Apparently the need for the true dam was not so pressing in Egypt with its Lake Moeris and other natural advantages. History fails to show when and where the first storage dam was constructed, but crumbled remains of irrigation works have been found in the jungles of Ceylon, covered with overgrowth and obviously of considerable antiquity. And from the East Indian term applied to such works, "tanks," it may be hypothesized that these dams were true dams, storing water supplies of the present for future use.

The oldest true storage dam known today is located in Europe on the Segura River in the province of Murcia in Spain. It is said to be 800 years old. Also in Spain is another old storage dam of note which is built astride a narrow gorge carved out by the Monegre River in the province of Alicante. This dam is said to date from 1579. It was 140 feet high and 100 feet long, stored water for the irrigation of 9,000 acres.

Grand Coulee Dam, Columbia Basin Project, Washington



Shasta Dam, Central Valley Project, California

These Spanish dams were probably the result of Moorish influences which had absorbed the irrigation knowledge of Babylonia and Egypt and brought it with them in their conquering westward march. Then, in a new and mountainous land and with a fresh outlook, the inherited knowledge of the past was advanced still further. Compared with the simple check dams of Egypt, the Spanish storage dams were quite a stride forward.

But even the Spanish dams are child's play compared with those built here in the United States. Boulder towers to a height of 726.4 feet, more than half that of the Empire State Building in New York City, the tallest building in the world. It has a storage capacity of more than 30,000,000 acre-feet of water, 80,000 gallons for every man, woman, and child in this country. And Grand Coulee dam, now building, is four-fifths of a mile of solid concrete 500 feet thick at bedrock base, spreading over 35 acres, and will store enough water for the irrigation of more than 1,000,000 acres.

More interesting and much more significant, in contrasting Bureau of Reclamation dams with those of the past, is the impressive advance in function. Our present-day dams are not only great storage dams for irrigation but flood control dams, domestic water supply dams, and electric power dams, all simultaneously. They are complex multi-purpose structures with labyrinths of internal passages, with remote control boards full of buttons and switches and flashing colored lights, with 40-story elevators, with 500-ton steel gates that lift at the push of a little finger, with 100,000-horsepower turbines and 1,000-ton generators capable of supplying a million homes with bright electric light.

The Majestic Culmination

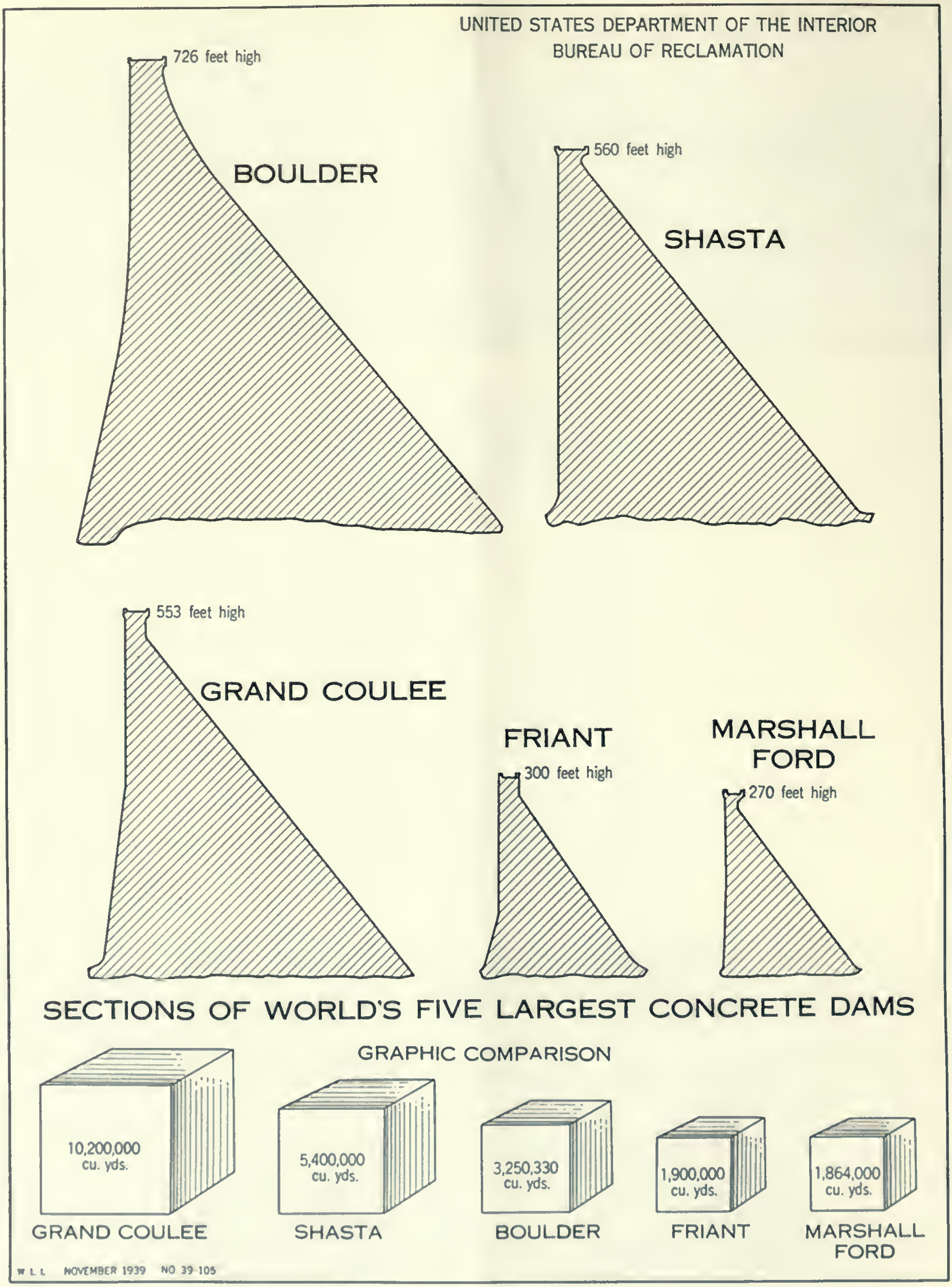
They are in brief the majestic culmination of milleniums of irrigation practiced by mankind since the beginning of civilization. It might not be considered unreasonable to draw the conclusion that our present-day American social organization is therefore the highest and furthest advanced of all cultures, the crown of all the ages.

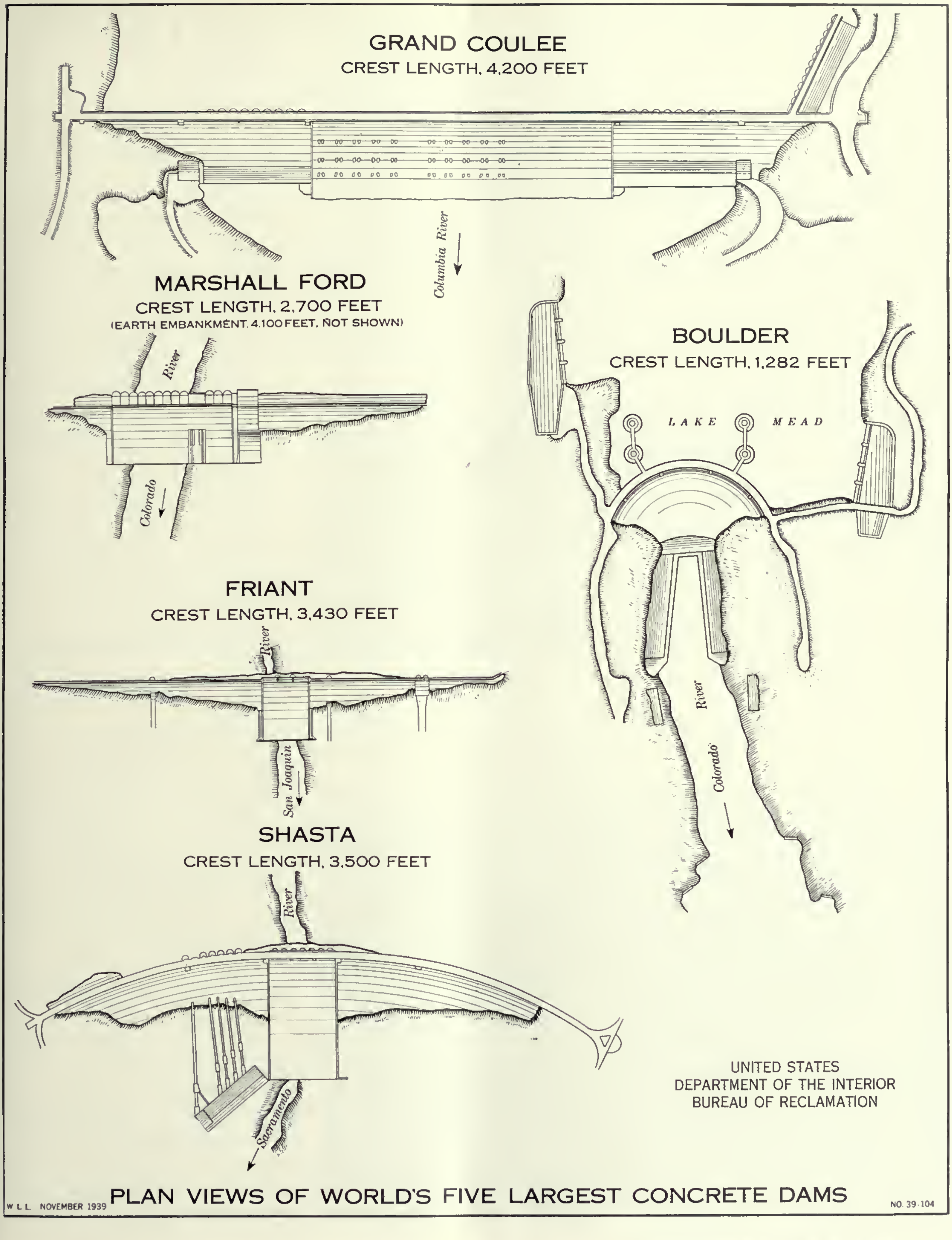
If that is the case, and if Mr. Garrett's statement that we are now in our own monumental stage is true, there appears a striking difference between our monumental works and those of the past, a difference of far-reaching implications in considering the real progress of mankind. The Pyramids of Egypt were royal tombs; they were built for the personal gratification of an individual, and so also were most of the other lasting works of antiquity.

In the United States, however, if by some chance our civilization several thousands of years hence is destroyed and vanishes from the face of the earth, the great engineering works of the Bureau of Reclamation will stand as silent testimonials to the fact that they were constructed not for the glorification of one individual, nor even the gratification of a few, but for the benefit of all. They are truly monuments to the living.

Friant Dam, Central Valley Project, California

Marshall Ford Dam, Colorado River Project, Texas


UNITED STATES DEPARTMENT OF THE INTERIOR
BUREAU OF RECLAMATION
726 feet high
BOULDER
560 feet high
SHASTA
553 feet high
GRAND COULEE
FRIANT
300 feet high
MARSHALL FORD
270 feet high
SECTIONS OF WORLD'S FIVE LARGEST CONCRETE DAMS
GRAPHIC COMPARISON
10,200,000 cu. yds.
GRAND COULEE
5,400,000 cu. yds.
SHASTA
3,250,330 cu. yds.
BOULDER
1,900,000 cu. yds.
FRIANT
1,864,000 cu. yds.
MARSHALL FORD
W. L. L. NOVEMBER 1939 NO 39-105



W. L. L. NOVEMBER 1939 PLAN VIEWS OF WORLD'S FIVE LARGEST CONCRETE DAMS NO. 39-104

Power Drops on All-American Canal

By RICHARD K. DURANT, *Engineer*

THE construction of drops on the All-American Canal, so that future power plants can be combined with the drop structures, has been a major feature in the construction of the canal. Though the primary purpose of the All-American Canal of the Boulder Canyon project being built by the Bureau of Reclamation is to furnish water for irrigation and domestic purposes to the Imperial and Coachella Valleys in southern California, the providing of means for the generation of electrical power from the fall of water at drops in the canal has been of great importance to the water users.

The contract between the Federal Government and the irrigation districts only required a structure that would permit the flow of irrigation water over the drops. The districts, desirous of securing the maximum possible revenue from the sale of electrical power for the repayment of construction costs, requested that where feasible the drops be so constructed that power plants might be installed in the future as the demand for power developed. Through the efforts of the districts, the Secretary of the Interior approved the expenditure of funds for the purpose of constructing the substructures of powerhouses as a part of the canal drops.

The All-American Canal will carry water 80 miles from Imperial Dam, on the Colorado River, about 15 miles northeast of Yuma, Ariz., to a point 10 miles west of Calexico, Calif. After the canal swings away from the Colorado River near the International Boundary between the United States and Mexico and crosses a large sand hill region, it continues across a wide desert mesa into the Imperial Valley. From the sand hills to the Imperial Valley, approximately 27 miles, the water surface in the canal has a total fall of 145 feet. The canal gradient, which is about 0.45 feet per mile, utilizes 12 feet of fall. The remaining 133 feet is concentrated at 5 drops, which are designated by numbers 1 to 5, inclusive. Drop No. 1 only lowers the canal water 11.53 feet and no provision has been made for the generation of power. At all of the other drops, substructures for future power plants have been constructed. The designed capacity of the 8 hydroelectric units that will be eventually installed at the 4 power drops is 46,000 kilowatts.

Power drop subdivisions

In general, each power drop can be roughly divided into 7 parts—the powerhouse foundation, the intake flume, two spillway channels, the gate structure, the inlet transition and the outlet transition or tailrace. The powerhouse foundation is located in the center of the canal at the base of the drop. The intake flume is directly upstream from the powerhouse foundation, extending upstream to the gate structure. Along each side of the intake flume and the powerhouse foundation is a spillway channel with a stilling pool at the lower end. The gate structure extends across the canal at the upstream end of the spillways and intake flume. Immediately upstream from the gate structure is the inlet transition consisting of a concrete lined canal section and transition. Immediately downstream from the powerhouse foundation and outlet of the spillways and extending to the end of the structure is the tailrace and outlet transition.

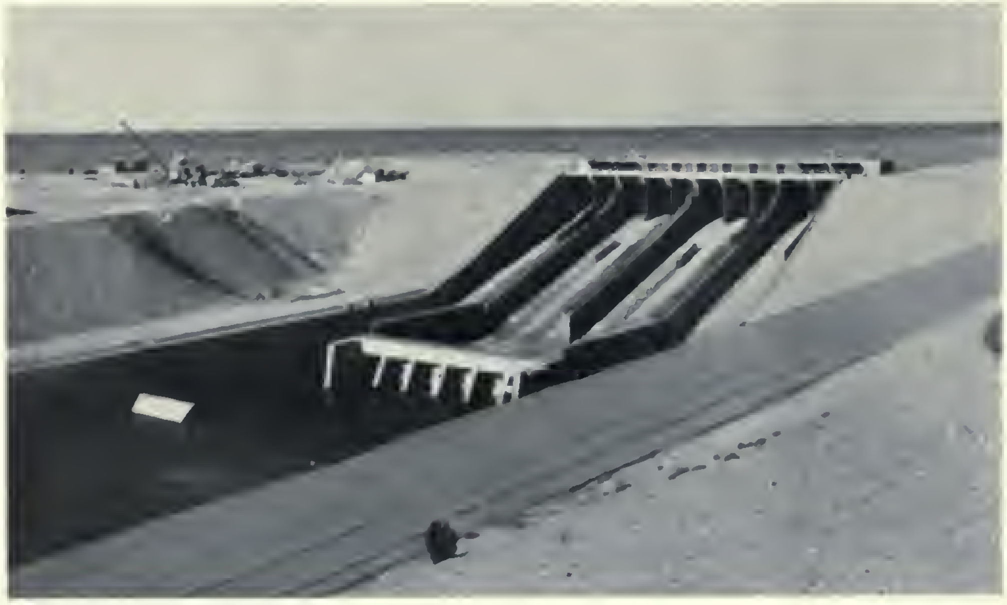
Previous to the period of construction, extensive tests were made into the foundation of all the power drop sites to determine the foundation conditions. Test wells, drilled 75 feet below the canal grade downstream from the drops, made known the earth's formation well below any portion of the structures. These wells at Drops 2, 3, and 4, showed that the desert sand was not just on the surface, as it sometimes is, but had considerable depth. Some of the wells penetrated to 130 feet below the natural ground surface and passed through coarse desert sand similar to that on the surface. Occasional thin layers of adobe clay were encountered, but it was generally sand all the way. At Drop 5, which is on the floor of the Imperial Valley, a different condition was found, and the wells passed through successive layers of adobe clay and Colorado River silt.

As all four power drops are similar in design and vary only in dimensions to fit the amount of drop in canal grade and canal capacities, no attempt will be made to describe the individual structures, but the following description will, in general, cover all the power drops. Two drawings for Drop No. 4, which are considered typical, are reproduced herewith.

The driving of the timber bearing piles was one of the more extensive individual features of construction and a total of 8,264 50- and 25-foot piles were driven for the four drops. Piles at Drops 2, 3, and 5, were driven with a single-acting steam hammer, which was used with leads suspended from the end of a dragline boom. The work at Drop 4 was done with a double-acting steam hammer and a skid rig. The ground conditions at all the drops were such that the use of water and air jets was necessary to drive the piles to their full penetration. At Drop 5, 188 50-foot piles were driven on a 1:3 batter. These were driven with the same equipment as the vertical piles. The leads suspended from the dragline boom could be easily set to drive the piling on the required batter.

The powerhouse substructure, the portion completed by the Bureau of Reclamation, provides a completed foundation for a 2-unit hydroelectric plant. The entire foundation rests upon a group of 50-foot timber piling with a varied spacing of from 3 to 4 feet in both directions. The tops of the piling ex-

Power Drop No. 2. First stage construction completed



tended above the grade of the excavation and a reverse filter was constructed around the piling, and over the entire area under the powerhouse. The reverse filter consisted of several layers of graduated sand and gravel for a total depth of 3 feet and 6 inches. A 12-inch layer of fine sand was first placed on the subgrade of the excavation, then followed by 6-inch alternated layers of pea and 1-inch gravel and a final 18-inch layer of 1½-inch gravel.

Embedded in the coarser gravel is a drainage system composed of 6- and 8-inch diameter cast-iron pipe. The pipe was installed with open joints and the two sizes were alternated. This collecting system feeds to 6-inch pipe lines that discharge through outlets on the downstream side of the powerhouse and into drainage wells located on the outside of the spillway walls. To hold the top surface of the filter to a firm subgrade for the placing of concrete and to prevent the leakage of mortar into the filter, the entire filter was covered with 1 inch of gunite.

A heavily reinforced concrete slab varying from 3 to 11 feet in thickness was placed on top of the piling with piles embedded in the concrete 9 inches for Drops 2, 3, and 5, and 2 feet for Drop 4. On top of this slab were constructed the substructure portions of the walls of the powerhouse and the outlet sections of the draft tubes. The walls were completed to an elevation well above the water surface in the canal downstream from each drop. Openings were left in the center of each unit for the future installation of steel draft tube liners. In these recesses anchor bolts and supports are provided to facilitate installation. Cast-iron drainage pipe and electric conduits are embedded in the substructure for the future power plant.

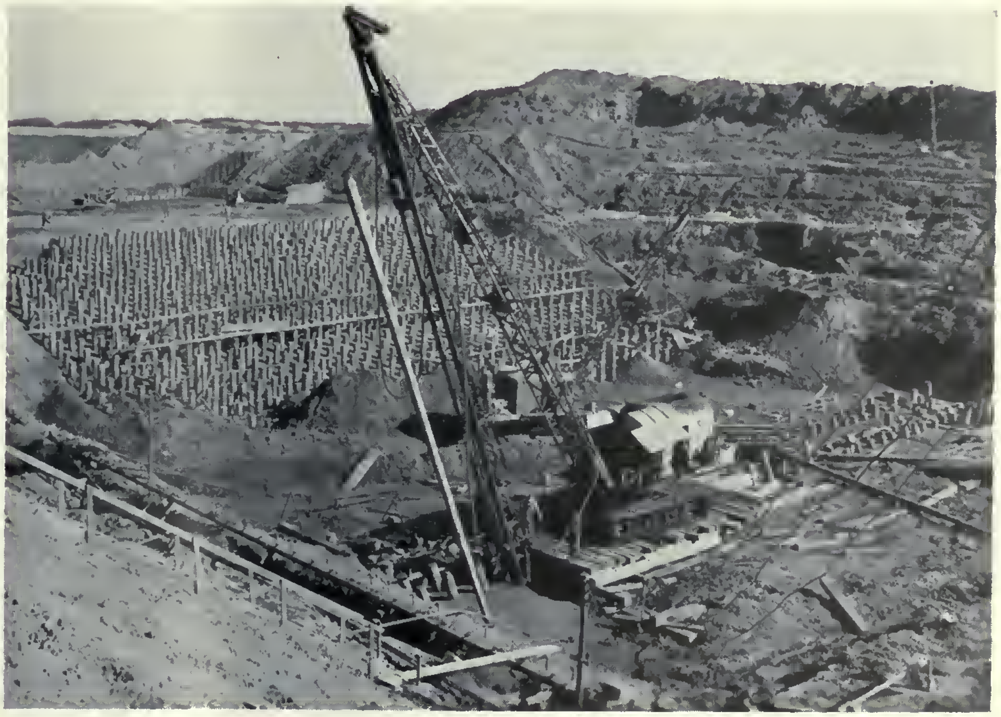
On all portions of the substructure that will be added to in the future, and where the junction of the two stages of construction will be subject to water pressure, stainless metal water seals have been provided to increase the watertightness of the future construction joint. Reinforcing steel dowels have been left protruding sufficiently to tie into future construction. At the outlet of the six draft tubes, steel guides and bronze seals have been installed for the operation of bulkhead gates that will be used to seal the draft tubes and permit dewatering for future construction purposes, and for maintenance.

The intake flume when completed will serve as a forebay and penstocks for the completed powerhouse. Only sufficient work has been completed by the Government on this part of the structure to permit the flow of water through the spillways. At Drops 2, 3, and 4, the foundation for the flumes consisted of a heavily reinforced concrete slab that varied in thickness from 18 inches at the upstream end to 36 inches at the powerhouse foundation. The slab was placed on natural ground and upon thoroughly compacted backfill that was placed after the completion of the powerhouse foundation. A reverse filter was provided for

Power Drop No. 3. Inlet of drop and gate structure

Power Drop No. 4. First stage construction completed

Power Drop No. 5. Showing excavating, pile driving, and well-point system



under the slab adjacent to the powerhouse foundation, that extends the entire width of the flume. Drainage pipe was embedded in the filter, similar to that under the powerhouse foundation, and discharge is made into the spillway channel.

The less stable ground conditions at Drop No. 5 required a foundation of design differing from those provided at other drops. A double slab rests upon the piling, the two slabs being separated by cross walls, forming a cellular-constructed single slab. Before the top slab was placed, the cells were filled with compacted material obtained from excavation.

On top of the foundation slabs, the outside walls of the flume, which also constitute one side of the spillway channel, were partially completed to a height sufficient to permit the flow of water down the spillway channels. Inverted keys and dowel reinforcing steel were provided for the future construction of the division walls between the penstocks and trash racks.

Spillway Channels

The spillway channels on each side of the structure consist of a chute and stilling pool with capacities for 7,600, 7,400, 7,100, and 4,300 second-feet for Drops 2, 3, 4, and 5, respectively. The bottom slabs of the channels are of identical construction and are a continuation of the foundation slabs of the intake flume and powerhouse substructure, though in some places these are divided by expansion joints. The slopes of the chutes and upper part of the stilling pools are 3:1. This slope comes into a vertical curve at the bottom of the stilling pool from which the bottom slab slopes up to the tailrace and outlet slabs on various slopes for the different drops, varying from 5.88:1 to 9.51:1. The outside wall of each chute is a cantilevered wall with a wide footing. The stilling pool walls are buttressed and rest upon a slab that is a continuation of the stilling pool and powerhouse foundation slabs. To aid in the dissipation of energy, dentated sills and baffle piers are constructed at the bottom of stilling pools. To protect the sills and piers from erosion that might occur due to high velocity, the edges that are subjected to this influence are protected with structural steel plates and angles.

The gate structure will control the flow of water through the drop. For Drops 2, 3, and 4, provision has been made for 10 radial gates, and for Drop 5, 8 gates. The 2 gates at each end of the gate structure, control the discharge of water into the spillway channels, and have been installed by the Government. The remaining gates are for the power plant and will be installed by the Imperial Irrigation District when the generating machinery is installed. The end gates are automatically controlled by counterweights and floats, the elevation of the gates being determined by the elevation of the water in the float well, which is established by an adjustable weir; the other gates are operated by electrical hoists. The automatic gates are so arranged that they can also be operated mechanically, if necessary.

The inlets to the structures consist of a short length of concrete-lined canal connected to the gate structure by a transition section. The sides and bottoms are constructed in varied dimensioned sections having expansion joints between adjacent sections. The expansion joints are formed with rubber water stops and premolded filler material which prevents leakage through the joint and permits movement for expansion and contraction. The joints were spaced at locations that serve to prevent or reduce concrete cracking as much as possible. To reduce seepage and to prevent the piping effect of water under the structure, a cut-off wall extends across the full width of the structure at the upstream end of the lined canal. The cut-off wall consists of 40-foot steel sheet piling with a 6-foot concrete cap on top that was constructed monolithically with the canal lining.

The outlets from the structures are composed of tailrace and transition sections. The tailrace, immediately below the outlet of the draft tubes and the stilling pools of the spillway channels, is of rectangular cross section with buttressed vertical walls on the sides. The bottom is paved with a reinforced-concrete slab varying from 12 to 18 inches in thickness. Sills of 5-foot height extend from the sides. The transition section is of construction similar to that of the upper transition with a cut-off wall of 10-foot steel sheet piling extending the full width of the structure. The sides and bottoms were constructed in varied dimensioned sections with expansion joints between the adjacent sections.

Construction

The construction was executed by contract under four schedules, each drop comprising one schedule. Bids were opened on February 15, 1937, and contracts were awarded to the lowest bidders. The construction work at Drops 2 and 3 was performed by the Pleasant-Hasler Construction Co., and Drops 4 and 5 were constructed by Frank J. Kernan and John King.

The methods of construction for the different drops were quite similar, varying slightly with the different types of equipment of the two contractors. The excavation for Drops 2 and 3 was accomplished with a 2-yard dragline and a bulldozer. Drop 4 was partly excavated with a three-fourths-yard Sauerman slack line and the remainder was removed by dump trucks which were loaded with a small dragline. Drop 5 was excavated partly with a 2-yard dragline and finished with a smaller machine dumping into dump trucks.

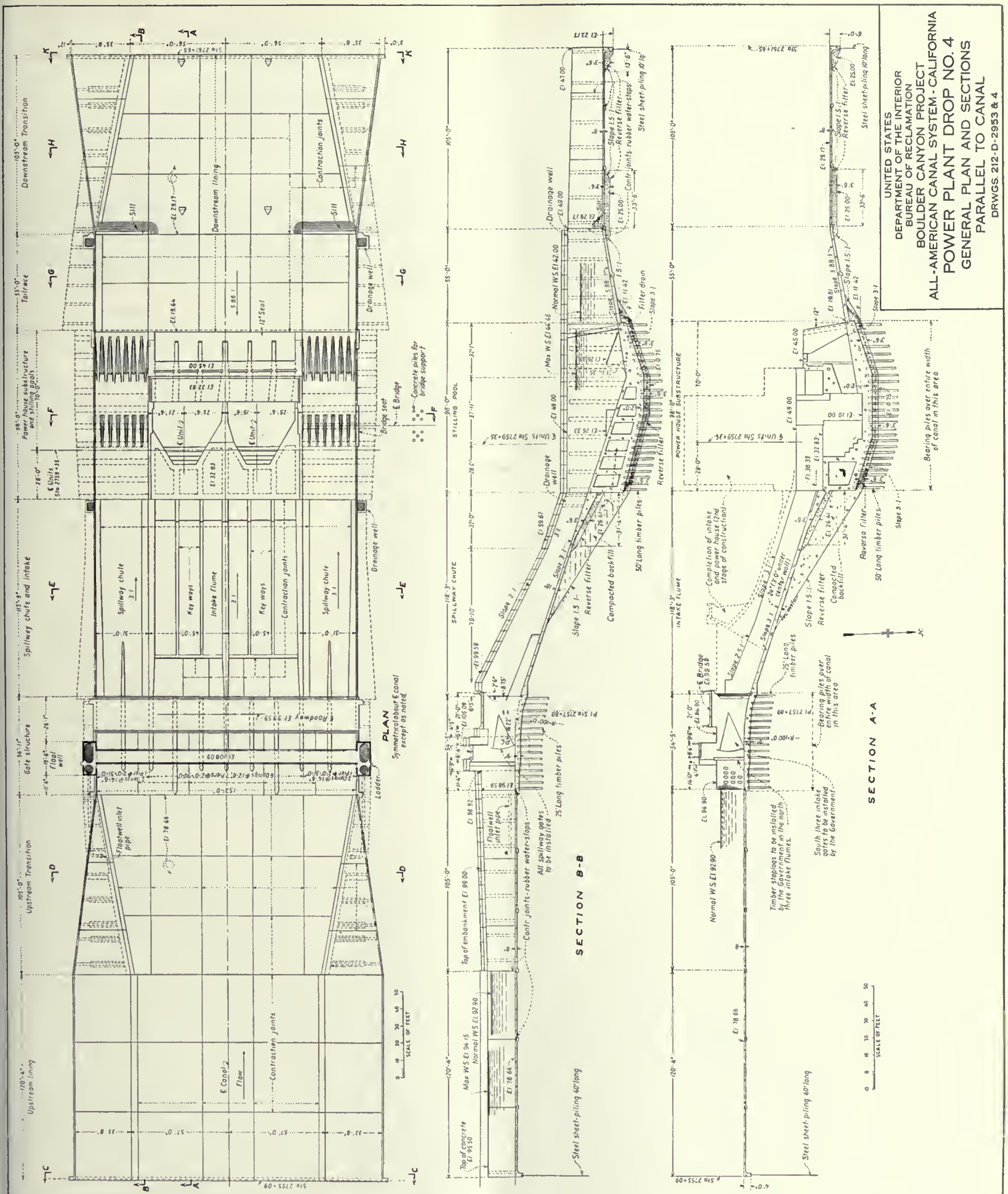
The bottom of the powerhouse excavation at Drops 4 and 5 was at a considerable depth below the natural water level, and an extensive dewatering system was installed at both structures. At Drop 4 it became necessary to lower the ground-water elevation approximately 28 feet. A system of well points was utilized and the texture of the ground was sufficiently open to permit the flow of water to the points so that no great difficulty was encountered in dewatering. The number of points used was varied to fit conditions as construction progressed and approximately 100 was the average number required. The header lines were attached to three 6-inch vacuum pumps. By the use of valves in the header lines, the entire system could be pumped by either one, two, or three pumps. After the water had been lowered to the bottom of the excavation, the average discharge of all the pumps was 450 gallons per minute. Some of the water was diverted and used in jetting operations upon foundation piling. The portion of the well-point system that was under the concrete foundation was left in position when the concrete was placed. Pumping was continued until all construction was completed to a point above the original ground water elevation and then that portion of the dewatering system outside the structure was removed.

The nature of the terrain at Drop 5 was such that dewatering operations were conducted in a different manner from those at Drop 4. It was necessary to lower the ground-water elevation 36 feet. A well-point system somewhat similar to that used at Drop 4 was installed, but the porosity of the silt-laden sand was not sufficient to permit the flow of water to the points as quickly as was required. Before the well points would collect any water, it was necessary to embed the points in coarse sand and fine gravel to overcome the obstruction presented by silt. To speed up the dewatering, open-sump pumping was resorted to. When the water surface in the excavation was lowered faster than the ground water was being lowered by the well points, slides occurred on the sides of the excavation and wooden sheeting was driven at some places to correct this condition. When the excavation and pile-driving was completed and the reverse filter was placed, water was pumped direct from the reverse filter. By the continued pumping from the well points and from the reverse filters, the construction area was sufficiently dewatered to permit the placing of concrete. As soon as the structure was completed above the natural ground water elevation, the well points were pulled and pumping was continued from the reverse filter only. The average total pump discharge to keep the construction area dewatered was 150 gallons per minute.

Reinforced Concrete Work

The construction of the reinforced concrete portion of the drops followed usual routine and no unusual problems were encountered that are not ordinarily found in heavy reinforced concrete work. For the four power drops 58,851 cubic yards of concrete were placed in which there were 9,349,587 pounds

(*Continued on page 52*)


UNITED STATES
DEPARTMENT OF THE INTERIOR
BUREAU OF RECLAMATION
BOULDER CANYON PROJECT
ALL-AMERICAN CANAL SYSTEM - CALIFORNIA
POWER PLANT DROP NO. 4
GENERAL PLAN AND SECTIONS
PARALLEL TO CANAL
DRWGS. 212-D-2953 & 4
PLAN
Symmetrical about ℄ canal except as noted
SECTION B-B
SECTION A-A
Upstream lining
Upstream Transition
Gate structure
Spillway chute and intake
Power house substructure and stilling pools
Tailrace
Downstream Transition
Downstream lining
Spillway chute
Intake flume
Key ways
Contraction joints
Drainage well
Float well
Floatwell inlet pipe
℄ Canal
Flow
℄ Roadway El 99.59
℄ Units Sta 2759+35
℄ Bridge
Bridge seat
Concrete piles for bridge support
Sta 2755+09
Sta 2761+65
Stilling pool
Normal W.S. El 92.90
Max W.S. El 94.15
Normal W.S. El 42.00
Max W.S. El 44.46
Top of embankment El 99.00
Top of concrete El 95.50
All spillway gates to be installed
Contr. joints-rubber water-stops
Steel sheet-piling 40' long
Steel sheet-piling 10' long
25' Long timber piles
50' Long timber piles
Compacted backfill
Reverse filter
Filter drain
Bearing piles over entire width of canal in this area
Timber stoplogs to be installed by the Government in the north three intake flumes
South three intake gates to be installed by the Government
Completion of intake and power house (2nd stage of construction)
Slope 2:1
Slope 3:1
Slope 1.5:1
Slope 5.88:1
SCALE OF FEET

Umatilla Farm Cooperatives

By WILLIAM L. TEUTSCH, *Assistant State County Agent Leader, Oregon State College*

THE most completely organized community for cooperative marketing in the United States, that is how Oregon marketing authorities refer to the Hermiston District, located in the heart of the Umatilla Reclamation project in Umatilla County, Oregon. Eighty percent of the farmers on the project and in the Hermiston area are members of one or more producer-owned and controlled cooperative associations. This record compares favorably with that greatest of cooperative countries, Denmark.

The list of cooperative associations, some of which have been in existence for more than 15 years, includes the Farm Bureau Co-op which handles feeds, seeds, and fertilizers; a cooperative oil company which handles gasoline and oil; the Umatilla Cooperative Creamery, including a cold-storage locker department; Hermiston Co-op Laundry and Cannery; the Grange Cooperative, devoted to merchandising of hardware and farm machinery; the Hermiston Mercantile Cooperative, groceries; Eastern Oregon Turkey Growers Association; Hermiston Federal Farm Credit Union; and the organization most recently formed under the REA, the Umatilla Electric Cooperative Association. In addition, of course, there is the Umatilla Reclamation project itself, which in effect likewise is a cooperative.

Thus in this rural community of irrigated farms every major commodity produced finds its outlet to market through a producer-owned and controlled association. Likewise, in substantial measure, the product which farmers must use, even including credit, can be obtained through a producers-owned association. It is a situation so unique in the entire Pacific Northwest that I sought the answer from the local pioneers and leaders in this cooperative movement as to why such progress had been made in the Hermiston area. A summary of the answers to this question, if these can be summarized, would go like this:

"Economic necessity forced us into cooperation in order to remain here and have for our families more of the good things of life, with a resultant higher standard of living. The results are evident in individual and community betterment."

One of the early reclamation developments, the Umatilla project opened for settlement in 1907, is located on coarse sandy-loam soil with a low duty of water. The characteristic mistake of early agricultural development of too small farm units was evident here. As late as 1926 the 500 farms in the project averaged only about 25 acres of cropland per farm. The cooperative movement, in the opinion of Hermiston leaders, has enabled them to overcome, in a substantial measure, these handicaps. Although there are about 1,000 farms in the Hermiston area, and only half of them on the project proper, the impelling force and leadership in this cooperative movement came from the project farmers.

"See our local banker," was the statement which several cooperative leaders made to me. "F. B. Swayze, our local banker, has financed and has been intimately associated with most of these cooperative efforts. He will be able to tell you to what extent these organizations have been financially successful." I sought out Mr. Swayze, who, incidentally, came to Hermiston when it was a sagebrush flat in 1906 and started the first bank in a humble structure on the site where the present fine stone structure stands. This bank has been open every banking day since that time and even did not close its doors during the bank holiday of 1933.

"Farmers in the community have received a higher percentage of the consumers' price and many services through cooperation which they could not otherwise have afforded," Mr. Swayze told me. "I have been interested in and supported this cooperative development purely as a business proposition. These cooperatives have provided a way by which we have built the community and widened our trade territory."

The Farm Bureau Cooperative, which in a recent year did $147,000 worth of business, with approximately 800 active members, was organized in 1924 and incorporated under the Oregon cooperative laws. This organization, according to H. M. Sommerer, present manager and one of the organizers, grew out of a simple proposition whereby farmers pooled their orders for feeds and coal. "The late C. J. Hurd, marketing specialist for the Oregon State College Extension Service, was a great help to us in setting up our organization on a sound basis," Mr. Sommerer said.

Bearing out Mr. Sommerer's statement, the annual report of the Umatilla County agent in 1923 shows that this matter was first discussed at a meeting of dairymen, at which time the county agent pointed out the poor economic system under which dairymen were buying their feed. They were purchasing only 2 or 3 sacks at a time on credit, and paying about 30 percent higher prices than necessary, and the dealers were not making any money either. That year, the county agent report shows, the Bank of Hermiston and the Farm Bureau effected an arrangement for buying in quantity for cash. Three hundred twenty-five tons of feed were purchased and 180 tons of coal, with a saving amounting to $2,700. That was the forerunner of the present successful business, a concern which now has a net worth of approximately $50,000.

Cooperative Service Station

An important department of this Farm Bureau, recently added, is the cooperative service station. It serves more than 500 members, selling gasoline, oils, tires, etc., at going retail prices and has been able to distribute a dividend to members amounting to approximately 10 percent.

The Umatilla Cooperative Creamery, organized on April 10, 1931, as one of the units of the Interstate Associated Creameries, the central marketing agency for cooperative creameries in Oregon, has been an outstanding success. Starting with 169 members, the association had 420 members on January 1, 1939. Pounds of butter manufactured likewise have increased from 371,000 pounds the first year to nearly 600,000 pounds in 1938, with a substantial increase again evident in 1939. Going prices for butterfat have been paid, plant improvements financed, and in addition more than $26,000 has been distributed in dividends up to the beginning of the current year.

A cold-storage food locker department, established in 1933 with money loaned the creamery by other cooperative organizations within the community provided 400 individual locker boxes, 70 percent of which are used by the members. This enables farm families in the community to grow their own fresh meat, fruit, vegetable supplies, store them away in these frozen food lockers, and have them available at any time of the year. It is another service provided at minimum cost which has helped to raise standards of living.

M. G. Hedwall is manager, under whose direction the creamery has broadened its service to the community. One of the most interesting cooperative enterprises of the community is the cooperative laundry and cannery. Doing the family washing was pretty much a matter of drudgery on these small irrigated farms. With summer temperatures ranging up to 110°, it was no fun to handle boilers full of hot water on scorching kitchen stoves. The idea originated with the Farm Bureau Co-op. While organized and maintained as a separate unit with its own manager, cash for financing the enterprise was provided by the Farm Bureau Co-op. Starting with one washing machine in 1931, six machines are now owned and provide modern laundry facilities to 175 families in the community. These machines are allotted out in 2-hour periods, the charge for which is 35 cents. Practically every period of every working day in the week is utilized. Hot water is provided through steam obtained from the Cooperative Creamery, located di-

Home of the farm co-op which serves 800 members

The modern killing and dressing plant of the Eastern Oregon Turkey Growers Association

Henry Ott, an outstanding cooperative leader of the district

John Jendrzejewski president of turkey growers

rectly across the street. Mrs. Baxter Hutchison is reported to have been the originator of this idea which took root immediately with other members of the Farm Bureau Cooperative.

As the Cooperative Laundry became successful, another family need was facilities to can various food products produced on the farm. Canning equipment was obtained and added as a part of the laundry. The use of the community cannery is scheduled in a manner similar to the laundry. Certain days are designated for packing asparagus, tomatoes, corn, and other products. Last year this community cannery was used by more than 300 different patrons and the pack totaled 68,836 cans. The greater portion of this pack is for home use, but a good market has been developed for canned goods in excess of home requirements.

"What effect is the fact that you now have electricity on most of the farms having on the volume of business which the laundry is doing?" I asked Alfred Sisson, manager of the plant, one Sunday morning as he explained its operation to me. "It is, of course, having some effect," he replied, "but not as much as you would think. Last year we had 200 regular users of the laundry, and this year I estimate we will have about 175. In fact, I still have a real problem of scheduling machines for use of patrons."

Starting on borrowed money, and operating on the basis of a service-fee charge, the association now has a net worth of $3,384. Financially successful, of course, but its major contribution has been its social value as much of the drudgery of the individual family washing and canning processes has been eliminated with this convenience.

The Eastern Oregon Turkey Growers' Association, of which John Jendrzejewski is president, which markets 80 percent of the turkeys produced in the area, is another outstanding example of successful cooperation. It is a unit of the Oregon Turkey Cooperatives, Inc., and markets its birds through the Northwestern Turkey Growers' Association, central marketing agency, with main offices at Salt Lake City, Utah. Harold Rankin, manager, showed me through the new modern killing plant which this association has just completed and through which the 1939–40 turkey crop was handled. Capable of killing, dressing, and cooling out a carload of turkeys daily, the plant is one of the most up-to-date to be found anywhere in the Pacific Northwest. This association was organized in 1930 and the first year handled 8,000 turkeys for local growers. Membership now numbers 120, and the association will pack out during the 1939–40 marketing period approximately 50,000 birds. It has been a leading force in developing the turkey industry and in improving quality.

The most recent cooperative effort was the organization of the Umatilla Electric Cooperative Association, formed to take advantage of the opportunity to bring electricity to hundreds of farms for the first time under the provisions of the Rural Electrification Administration. On July 16, 1938, 136 miles of rural power lines were energized, bringing service to 381 users. By July of 1939, the number of users had increased to 495 and the miles of lines energized to 157, with two or three extensions in the process of construction, indicating that this cooperative, too, is experiencing the customary growth. E. D. Martin, manager of the Umatilla project, is president of this association. Thus another cooperative effort brings to rural homes at nominal cost electricity, an essential to the most satisfying standards of rural life.

Since January 1, 1926, when funds were provided by the Federal Reclamation Service, the Extension Service has maintained an assistant county agent with headquarters at Hermiston. While the Federal Reclamation contribution was discontinued in 1934, an assistant county agent has been maintained as a regular part of the county extension staff in Umatilla County. In all this cooperative effort, the Umatilla County agent, the assistant county agent, and the extension specialist in marketing worked closely with local people in bringing about these sound developments.

Always the policy has been to start slowly on a sound basis, building on a modest start within a sound financial structure. The Inland Cooperative, a successor to the Grange Cooperative, organized in May 1939, handles hardware and fuel, with all stock paid for in cash. It has a net worth of $5,000 and renders service to several hundred members. Likewise the Hermiston Mercantile Co. cooperative, strictly of the consumer type handling groceries and similar commodities for members, has operated since 1934 and does an annual business of approximately $30,000 in this highly competitive field.

The leaders and their neighbors, through their support, have guided this cooperative movement on the Umatilla project and in the territory adjacent to it. It is the most unique and extensive in its service to farm families that can perhaps be found in any community in the United States.

Progress at Green Mountain Dam

CONSTRUCTION work on the Green Mountain Dam, unit of the Colorado-Big Thompson project located on the Blue River 16 miles southeast of Kremmling, Colo., is slightly ahead of schedule.

The temporary cofferdam was completed to sufficient height and the river diverted through the diversion channel on December 13, 1939 (see attached photograph). The diversion of the river marks the completion of an inlet approach channel, an 18-foot circular diversion tunnel, a 15½-foot circular inlet shaft (along with foundation for the trash rack), a gate chamber (to accommodate two 102-inch ring-sealed gates), a 20-foot diameter gate hoist shaft, a 15-foot 9-inch by 23-foot 3-inch modified horseshoe outlet tunnel (to accommodate two 102-inch diameter plate-steel penstocks, and an outlet channel (to be backfilled after completion of the power plant).

The minimum thickness of the circular tunnel concrete lining is 18 inches and that of the horseshoe section is 24 inches. The thickness of the concrete lining of the inlet shaft is 18 to 24 inches. The lining of the gate hoists shaft is 18 to 30 inches. The tunnel is 1,575 feet long; in addition there is 177 feet of lined channel and the lining was reinforced wherever the character of the rock through which it was excavated was poor. The diversion discharge, with 15 feet free board on the cofferdam, is 10,000 second-feet—approximately twice the recorded discharge.

The concrete gate plug will be placed in the diversion tunnel just upstream from the inlet shaft previous to placing the gates and penstocks.

The work on the dam proper is about 20 percent complete and the contractor expects to continue with stripping of the right abutment, river bed, and left abutment through the winter months. The contract calls for completion of the structure in May 1943.

Work is being performed by the Warner Construction Co., of Chicago, Ill.

Power Drops

(Continued from page 48)

of reinforcing steel. The construction of forms for concrete consisted of ply-wood panels made up in sizes for easy handling. The Pleasant-Hasler Construction Co. used a standard panel of 2 by 6 feet, and Kernan and King used larger panels, varying the size and shape to fit the special requirements of the work. The forms were supported by the usual method of walers and tie rods with "she-bolts." The ends of the rods were not installed closer than 2 inches of the surface of the concrete.

All concrete was mixed at stationary mixing and batching plants located near each drop. One-yard mixers were used and the concrete was conveyed from the mixers in one-quarter yard, pneumatic-tired buggies over temporary runways. At Drop 4, the contractor used a small pumpcrete machine for isolated pours that would have been difficult to reach with buggies. Little difficulty was experienced in maintaining a placing rate of 25 cubic yards per hour.

The concrete was dumped from the buggies into the forms through metal or rubber "elephant-trunk" chutes. The use of "elephant-trunk" chutes was a necessity in many places so that concrete could be placed without excessive segregation occurring. The mix was thoroughly worked by vibration with air-powered internal-type vibrators and by workmen who puddled the concrete while wearing rubber boots. In places where the width of the form did not permit men to wade in the concrete, long puddling sticks were used. All concrete was water-cured continuously for 14 days after placement.

The All-American Canal is located in a region with a hot and dry climate where extreme high temperatures prevail during the summer months. Temperatures of 120° are not unusual on the desert during the hottest part of the summer. The specifications for the construction of the drops provided that the temperature of concrete when being placed should not exceed 90° F., and that no concrete was to be placed during the months of June, July, August, and September. By the contractors' operations being limited during the summer months and by the difficulties of maintaining an efficient organization during the hot weather, operations were discontinued during the severest part of the summer.

The Imperial Irrigation District has awarded contracts for the construction of powerhouses and the installation of turbines and generators for one unit at each of Drops 3 and 4. These plants are expected to be completed and ready for operation during the summer of 1940.

Riverton Has Record Crop Year

BASED upon the local crop data, the average gross crop return for the Riverton project during the year 1939 was $22.01 per acre—the highest average ever reported by the project. The second highest average return was that of $20.78, for the year 1936. The latest increase is attributed to better marketing and to increased yields.

Green Mountain Dam

NOTES FOR CONTRACTORS

Specification No.	Project	Bids opened	Work or material	Low bidder		Bid	Terms	Contract awarded
				Name	Address			
880	Tucumcari, N. Mex.	1939 Nov. 16	Conchas Canal, station 0+00 to station 1342+70; earthwork, tunnels, and structures.	Utah Construction Co. and Griffith Co.	San Francisco, Calif.	[1] $562,027.00		1940 Jan. 4
				Jahn-Bressi-Bevanda Constructors, Inc.	Los Angeles, Calif.	[2] 1,309,582.00		Do.
				Brown and Root, Inc	Austin, Tex.	[3] 74,400.00		Do.
881	Minidoka, Idaho	Nov. 27	Turbine, governor, and generator for Minidoka power plant.	Baldwin-Southwark Corporation.	Eddystone, Pa.	[4] 69,720.00	F. o. b. Eddystone, Pa., and Rockford, Ill.	Jan. 3
				Westinghouse Electric and Mfg. Corporation.	Denver, Colo.	[5] 76,420.00	F. o. b. East Pittsburgh, Pa.	Do.
882	Columbia Basin, Wash.	Dec. 11	Rearing ponds and drainage, sewerage and water systems at Leavenworth station.	David Nygren	Seattle, Wash.	126,945.05		Do.
1307-D	Central Valley, Calif.	Dec. 18	Structural steel for temporary highway underpass at station 4977+43.29, Southern Pacific R. R. relocation.	Virginia Bridge Co.	Denver, Colo.	7,434.00	F. o. b. Pollock, Calif.	Do. 2
1309-D	do	Dec. 28	Construction of office building at Government camp at Friant Dam.	Midstate Construction Co.	Fresno, Calif.	19,319.00		Jan. 1
1311-D	Colorado-Big Thompson, Colo.	Dec. 27	Weather-stripping buildings and residences at Estes Park headquarters.	Ideal Metal Weather Strip Co.	Boulder, Colo.	1,059.00		Jan. 5
33390-A	Central Valley, Calif.	Dec. 15	Ties, joists, and spacer blocks; lumber.	Long-Bell Lumber Co.	San Francisco, Calif.	[1] 10,560.90	F. o. b. Coquille, Oreg.	Jan. 6
				do	do	[6] 10,150.09	do	Do.
48561-A	do	Dec. 12	Steel reinforcement bars (2,600,000 lbs.).	Colorado Fuel and Iron Corporation.	Denver, Colo.	69,900.00	F. o. b. Friant, Calif.; discount ½ percent on $0.17 less.	Do.
1314-D	Colorado River, Tex.	1940 Jan. 2	240 upper tracks for 12- by 12-foot bulkhead gate frames at inlet ends of outlet conduits at Marshall Ford Dam.	American Bridge Co.	do	34,911.00		Jan. 12
44431-A	Parker Dam Power, Ariz.-Calif.	1939 Dec. 27	2 crawler cranes, 10- and 17½-ton capacity.	Bay City Shovels, Inc	Bay City, Mich.	[7] 7,700.00	Discount ½ percent	Jan. 16
						[8] 12,000.00	do	Do.
1319-D	Columbia Basin, Wash.	1940 Jan. 4	1 oil purifier, 1 filter-paper drying oven, and 1 portable dielectric test set for Grand Coulee power plant.	The De Laval Separator Co.	Chicago, Ill.	[9] 5,300.00	F. o. b. Odair, shipping points Poughkeepsie, N. Y., Philadelphia, Pa., and Newark, N. J.	Jan. 15
1320-D	do	Jan. 5	Structural-steel framing for cold-storage and heating plant at Leavenworth station.	Wendnagel & Co.	do	2,845.00		Do.
1318-D	Rio Grande, N. Mex.-Tex.	Jan. 2	3 dragline excavators (¾, 1¼, and 1½ cubic yards).	Link-Belt Speeder Corporation.	do	[7] 8,750.00	F. o. b. Cedar Rapids, Iowa.	Jan. 19
	Tucumcari, N. Mex.			Northwest Engineering Co.	do	[10] 29,800.00	F. o. b. Green Bay, Wis.	Do.
1315-D	Shoshone-Heart Mountain, Wyo.	1939 Dec. 29	One 7½-ton, single-motor, traveling crane for installation in control works of Shoshone Canyon Conduit.	Maris Bros., Inc.	Philadelphia, Pa.	2,150.00		Jan. 18
1316-D	Boulder Canyon, Ariz.-Nev.	1940 Jan. 4	Aluminum rolling doors, windows, and louvers for switch house units A-1 and A-2-A-3, Boulder power plant.	Associated Material Co.	Los Angeles, Calif.	[7] 4,440.00	F. o. b. Oakland, Calif.; discount 1 percent.	Jan. 17
				Acme Ornamental Iron Works	Seattle, Wash.	[8] 4,750.00		Jan. 16
1317-D	Columbia Basin, Wash.	Jan. 3	One 8-by 8-foot float-operated radial gate with service platform, float and float-operating equipment; two 5-by 5-foot and two 5-by 3-foot 6-inch radial gates with hoist-frames and motor-operated hoists.	Schmitt Steel Co.	Portland, Oreg.	[7] 692.00	Discount ½ percent	Jan. 18
				Machinery Builders, Inc.	Long Island City, N. Y.	[8] 1,702.00	Discount 1 percent	Jan. 19
1322-D	Parker Dam Power, Ariz.-Calif.	1939 Dec. 29	80,000 barrels of low-heat portland cement in bulk.	Monolith Portland Cement Co.	Los Angeles, Calif.	109,600.00	F. o. b. Monolith, Calif.	Jan. 19
1312-D	Columbia Basin, Wash.	1940 Jan. 2	Eleven 57-inch motor-operated butterfly valves for the spillway section of Grand Coulee Dam.	Commercial Iron Works	Portland, Oreg.	26,491.00		Jan. 26
875	Shoshone-Heart Mountain, Wyo.	1939 Sept. 11	Earthwork and structures, laterals 16 to 79, and sublaterals and checks.	Taggart Construction Co. and Charles M. Smith.[15]	Cody, Wyo.	239,909.95		Jan. 24
1321-D	Central Valley, Calif.	1940 Jan. 2	110,000 barrels of low-heat portland cement in bulk.	Pacific Portland Cement Co.	San Francisco, Calif.	147,400.00	F. o. b. Sacramento	Jan. 23
1310-D	Columbia Basin, Wash.	1939 Dec. 27	Brass and copper pipe, bronze fittings, valves and appurtenances for ice-prevention air system at Grand Coulee Dam.	Barnett Fuel & Oil Co.	Denver, Colo.	[7] 1,694.35	F. o. b. Odair; discount 1 percent.	Do.
				Consolidated Supply Co.	Portland, Oreg.	[8] 2,234.13	do	Jan. 24
				Crane O'Fallon Co.	Denver, Colo.	[11] 433.46	F. o. b. Odair; discount 2 percent.	Jan. 22
				do	do	[12] 3,095.78	do	Do.
				Consolidated Supply Co.	Portland, Oreg.	[13] 2,082.77	F. o. b. Odair; discount 1 percent.	Jan. 24
				Crane O'Fallon Co.	Denver, Colo.	[14] 1,142.26	F. o. b. Odair; discount 2 percent.	Jan. 22
1292-D	Colorado-Big Thompson, Colo.	Oct. 12	Construction of 115-kilovolt transmission line, Greeley to Fort Morgan, Colo.	Larson Construction Co.[16]	do	33,364.50		1939 Dec. 11
B-38088-A	Columbia Basin, Wash.	1940 Jan. 8	Steel reinforcement bars (7,105,000 pounds).	Bethlehem Steel Co.	San Francisco, Calif.	[1] 23,500.00	F. o. b. Odair; discount ½ percent b. p. v.; shipping point, Seattle	1940 Jan. 30
						[6] 143,632.50	do	Do.
88	Colorado-Big Thompson, Colo.	Jan. 4	Power transformers, switching equipment, step-voltage regulators and lightning arresters for the Brush, Fort Morgan, and Wiggins substations.	Pennsylvania Transformer Co.	Pittsburgh, Pa.	[1] 21,372.00	F. o. b. Brush.	Do.
				do	do	[6] 30,686.00	F. o. b. Fort Morgan	Do.
				do	do	[5] 23,229.00	F. o. b. Wiggins	Do.

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[1] Schedule 1.
[2] Schedules 2, 3, and 4.
[3] Schedule 5.
[4] Schedules 1 and 2.
[5] Schedule 3.
[6] Schedule 2.
[7] Item 1.
[8] Item 2.
[9] Items 1, 2, and 3.
[10] Items 2 and 3.
[11] Item 3.
[12] Item 4.
[13] Item 5.
[14] Item 7.
[15] Originally awarded to the Bushman Construction Co. of St. Joseph, Mo., who was allowed to withdraw.
[16] Low bidder was Frank L. Zybach, who refused to execute a contract.

Combine Business with Pleasure in Tree-Planting on the Farm

By ROBERT B. BALCOM

MANY farmers on reclamation projects consider trees a nuisance and give little thought to what trees can do for them. Tree planting can be made both a pleasure and a good business proposition. If properly placed, trees will do a double duty on the farm—protect and beautify.

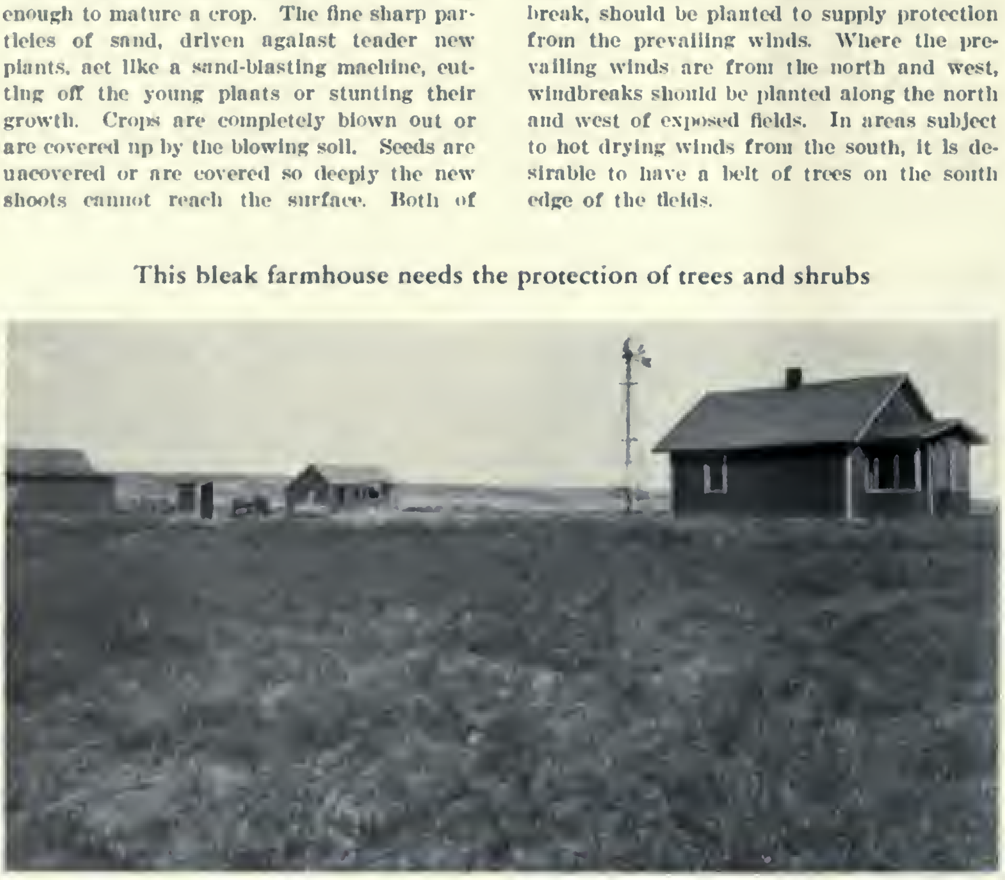
What can trees do for the farm? They will protect crop land from erosion, shelter orchards and gardens, reduce costs in feed lots, beautify and shade the home grounds, keep the home and other buildings warmer in winter and cooler in summer, supply lumber and fuel, protect wildlife, and help to create the intangible something that makes a house a home and living a pleasure.

Trees are needed for protection of crop land much more in some sections of the country than in others. Where the soil is light and sandy and the area is subject to strong winds, trees perform the greatest usefulness. Soil of this type, although it may be fertile and capable of producing good crops, in the more exposed areas often will not lie still long enough to mature a crop. The fine sharp particles of sand, driven against tender new plants, act like a sand-blasting machine, cutting off the young plants or stunting their growth. Crops are completely blown out or are covered up by the blowing soil. Seeds are uncovered or are covered so deeply the new shoots cannot reach the surface. Both of these conditions may occur in the same field.

When this transferring of top soil takes place, it leaves "blow outs" and mounds on the surface. Much work is then necessary to put the land in such condition that irrigation will give the required even penetration for growing fine crops. And there is no assurance the soil will remain stable. In addition, the fertile top soil blown into ditches or waste areas not only makes additional work for a farmer in keeping his ditches clean but may mean the total loss of the best soil on the farm. Even on the heavier types of soil, dust can be seen blowing from a plowed field in a high wind, taking the best soil from the farm unit.

Will trees prevent all this? We cannot say that trees are the panacea for all the harm that may be caused by winds on sandy lands, but with their use many of the ill effects can be overcome. Tests indicate that a tree belt gives protection for a distance about 20 times its height and some shelter for a greater distance. Trees, to be effective as a windbreak, should be planted to supply protection from the prevailing winds. Where the prevailing winds are from the north and west, windbreaks should be planted along the north and west of exposed fields. In areas subject to hot drying winds from the south, it is desirable to have a belt of trees on the south edge of the fields.

This bleak farmhouse needs the protection of trees and shrubs



A windbreak for protecting cropland should consist of three or more rows, planted in stairstep fashion. If many rows can be planted, tall varieties should be placed in the center and smaller bushy types, on each side. When circumstances limit the break to three or four rows, the small trees should be on either the outside or inside. Most of the taller kinds of trees eventually lose their lower limbs, through self-pruning, because of the close spacing necessary in a windbreak. Rows of bushy species should be placed closer, thus preventing undercurrents from coming through. Trees should be spaced farther apart on dry than on irrigated land. Under irrigation, the rows should be spaced 8 to 12 feet apart. The trees which ultimately will grow larger should be placed 8 to 12 feet apart in the row, but if of the shrub type, the trees should be 4 to 6 feet apart in the row.

Along with winbreaks other good conservation practices should be employed, such as strip farming and deep listing of fall-plowed fields at right angles to the prevailing winds. These extra precautions should be taken in any event until the trees have made sufficient growth to break the wind.

Plant Native Trees

The early discouragement encountered by farmers in tree planting was perhaps in part the result of selecting the wrong kind of trees. If possible, native trees or species that have been tried locally and found to be hardy should be planted; trees grown locally are usually better because they are acclimated. Trees grown from seed gathered in or around the project should be equally successful. Usually the county agricultural agent can supply a list of trees suitable for planting in each locality. The kind of tree to use depends on the annual rainfall or amount of irrigation water available, types of soil, and the location and purpose of the trees. In the Great Plains States, any of the following deciduous trees (trees that shed their leaves each fall) can be used for the taller types—American elm, hackberry, honey locust (thornless variety preferred), cottonwood (where plenty of water is available), and green ash. The cottonwood, while fast growing, is short lived at best. It is sometimes used to good advantage as a nurse tree, giving quick protection to the field and the slower growing, long-lived trees planted adjacent to it in the belt. For a shrub row use Chinese elm, Russian olive, mulberry, wild

Young trees and shrubs planted around this home will pay big dividends in protection in a few years

plum, and chokecherry. If any of the three latter are planted, they will give fruit as well as protection.

The most important type tree for any windbreak is the evergreen. In areas where drought-resistant species are needed, perhaps the two best are the red cedar and ponderosa pine (sometimes called western yellow or bull pine). To some people the name evergreen applies to a definite tree as the pine, fir, or spruce. Actually, it defines a group of trees which, as the name implies, retain their leaves or needles winter and summer: they are "ever green." Every field windbreak should have at least one row of evergreens and homestead windbreaks should have two or more.

The transplanting and care of the narrowleaf evergreen type of tree is generally less understood than that of the broadleaf deciduous variety. As a result there have been more failures with evergreens and subsequently fewer planted. However, no failures should result if it is remembered that the sap in evergreens is a resinous fluid which hardens readily in the roots when they are exposed to the air, causing "stoppage of the arteries" and that care to avoid such exposure must be taken when balling evergreens for transplanting. Balling is accomplished by digging a trench around the tree and wrapping burlap around the piece of earth encasing the roots. This burlap is particularily necessary if the soil is sandy and difficult to keep from falling off the roots, or if the tree is to be shipped or hauled any distance. Seedlings are sometimes transplanted without balling, but the roots must be protected by wet burlap. Trees transpire or give out moisture through their leaves. As evergreens retain their leaves throughout the year, they are really never completely dormant. For this reason, new plantings should be protected from wind and sun at any season of the year. Burlap can be staked around them, or for seedlings, shingles can be placed around them, in much the same manner that young tomato plants are protected.

Other Windbreak Advantages

Trees can assist in the conservation of moisture by preventing snow from being blown off the fields. It is a too familiar sight to see land swept bare of snow. If the land is unprotected by a windbreak the falling snow is blown into ditches and behind banks, where no good can be derived from it. Evergreen trees in a windbreak are best to stop this loss but even several rows of bare-limbed, broadleaf trees will check the wind enough to let much of the snow lie where it falls. When the snow is kept on the fields the accumulated moisture may eliminate the necessity of "irrigating up" the crops.

In some sections, orchards, small fruits, and gardens are greatly benefited if protected by windbreaks. Many farms, where orchards were once considered impractical, are now raising good fruit for home consumption in the shelter of trees. Too many farmers go without fruit, when perhaps a windbreak would solve their problem. It does not take a very large orchard with a patch of raspberries or other small fruit, to produce all the fruit a family will care to eat fresh and preserve for winter use, with some left to sell as a cash crop.

The same type of trees, as used to shield the orchard and garden, with perhaps a higher proportion of evergreens, should also be used as a windbreak for the home, feed lots, and barns. They should be placed in an L form to give protection along the sides where the prevailing winds strike. As in the fields, trees around a house give protection in winter as well as summer. The home can be kept warm in the winter with less fuel, and cool in the summer. Animals in barns and feed lots will be more comfortable and require less attention. Tests have proved that less feed is required to make the same weight gain for young stock where feed lots are protected. This means more profit to the farmer. Most anyone will exert himself to obtain personal comfort. If a home windbreak is planted for this reason alone, it will repay the farmer well for his trouble in the added comfort derived while doing chores in the winter. It is almost the same as going indoors to step behind a good evergreen windbreak when a stiff cold north wind is blowing.

The ways of using trees, already stated, should be sufficient to create an interest in a tree-planting program on every farm without elaborating on still other benefits derived. However, one actual return that can be measured in dollars and cents should be men-

Trees and shrubs are helping to protect and beautify this farm home

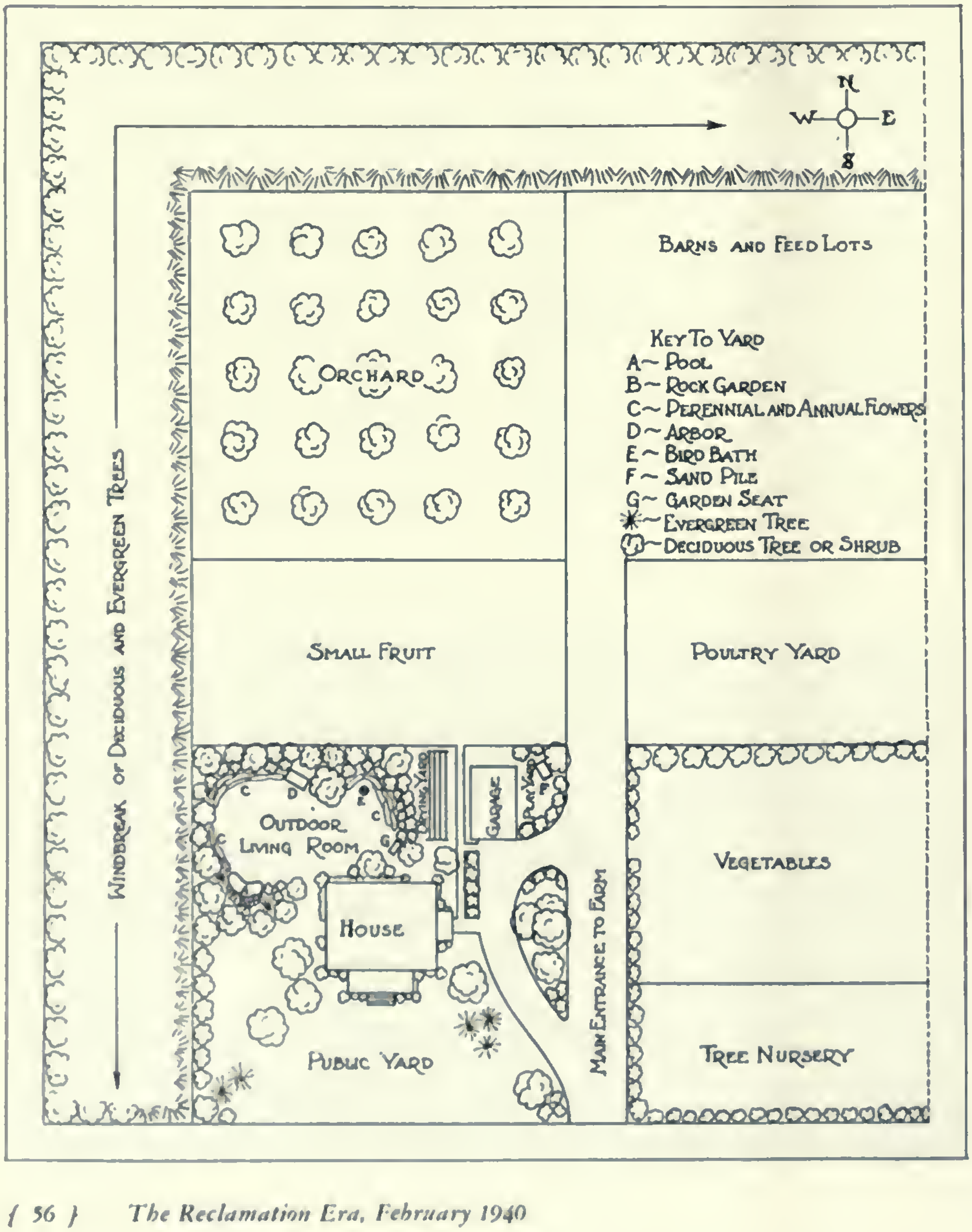
tioned. Every farmer needs wood for various purposes—fence posts, poles, lumber, and fuel. These can be obtained from the windbreaks as they reach a mature stage. Through good management many farmers are able to meet many of their timber needs from their own farms. The windbreak planted around the home and farm buildings may be widened to form a wood lot for growing fence posts and fuel and lumber. In addition, trees furnish cover and food for birds, which in turn repay the farmer by eating millions of injurious insects and weed seeds.

Making a Landscape Plan

A set of farm buildings without a tree or shrub near it presents a bleak, bare, homeless appearance. Even when poorly placed, trees give the feeling that someone lives on the farm, and it is much pleasanter to live in a home surrounded by green foliage. The shelter, planted for protection, will form the background for the buildings and a well-planned landscape program for the rest of the area will complete the picture. A typical planting arrangement is shown in the plan accompanying this article.

A rough plan for landscaping around the house can be made by stepping off the distances and transferring them in a suitable scale to a large sheet of paper. If this is done it helps to develop the area as a whole and prevents a hodge-podge appearance. All permanent buildings, walks, lanes, trees, and shrubs should be located on the plan. A well-planned home grounds usually contains three distinct areas—the public area, the work yard, and the private area. The part lying between the public road and the house is considered the public area and should be planted to give the house a setting, keeping in mind not to screen the house from the sight of passersby or to conceal the view of the approach road or walk from the house. The public area should consist of a well-kept lawn, a few trees, and foundation plantings of shrubs at the house.

Planting arrangement for a home by Robert B. Balcom



The trees near a house may be located to draw attention away from undesirable portions of the house, to shade windows from morning or afternoon sun, and to make the house seem an attractive part of a natural landscape. Lawn trees are more effective both in service and beauty if placed in groups rather than in straight rows. They should not be planted too near the house nor spaced too close together. Tall shrubs are desirable for planting at the corners of the house and low-growing bushes for planting under the windows and around porches at the entrance. The foundation of the house need not be entirely covered. Three or four of the same variety should be grouped together rather than placed hit and miss throughout the foundation planting. These can be chosen to give a variety to color of blossom and foliage during each season. Ornamental cedars, spruces, and pines may be used very effectively for lawn planting; they give a touch of life in winter after the deciduous plants have lost their leaves. Trees can also be used to screen out sheds and barns or any other undesirable views from the house.

The workyard area usually is comprised of a space for getting in and out of the garage, a place for turning around, and a drying yard. The space left in the center of the turn-around lends itself well to landscaping. A few trees and shrubs relieve the bare appearance and form a definite outline for the road. Clotheslines do not add to a landscape. For this reason, they should be screened away from the landscaped areas. However, the drying yard should be near the door where the heavy baskets of wet clothes are taken from the house.

The private yard, aptly called the outdoor living room, is a space designed for the enjoyment of the family. It is usually placed to one side or back of the house and is planted to give privacy from the highway and roads leading to the house. This area can be any size or shape but offers better landscaping possibilities if about twice as long as it is wide. The center is left open for lawn and the edges flanked with trees and tall shrubs. Inside of these are smaller shrubs skirted with perennial and annual flower beds. None of the planting, except the outside edge, should be in rows unless it is developed as a formal garden, and formal plantings do not usually adapt themselves for farm use as well as the informal type. The inside edges are irregular. The open lawn in the center is more useful and effective if it is not broken up by walks or odd-shaped flower beds. One end of the outdoor living room may have a lily pond, with an arbor facing it on the opposite side. Rustic seats, a bird bath, bird houses, and a sun dial may be used to good advantage but should be placed along the edges rather than in the center. Too many articles give the area a cluttered appearance. If a pool is used, it is better to build it irregular in shape and lay some rock in the fresh concrete to make it more natural. A rock garden using the material excavated from the pool makes a good addition if it can be designed to fit into the surrounding ground. A solitary pile of rock without a background is not very attractive but if the rocks can be placed in natural positions in the side of a hill or slope, it will look less artificial.

Developing a home in this manner takes a little time and work and perhaps some money, but it pays a hundredfold both in satisfaction and in increased value of the property. It need not be done all in 1 year, but with a definite plan it can be accomplished in a short time. Once a start is made, interest grows as the results of the work become evident. The boys and girls on the farm can help with this work and thus learn from experience the right way and the proper places to plant trees and shrubs. If the young folks share in making the farm attractive, as they grow up, they probably will be very proud that their community is a pleasant place in which to live and that they have helped to make it so.

Planting Stock

Many nurseries now supply good windbreak and ornamental stock at a very reasonable price. On some of the Federal Reclamation projects, the Bureau of Reclamation CCC camps have assisted in the development of nurseries for trees for wind-erosion control. These trees may be obtained also through the cooperation of other Federal agencies. Under the Clark-McNary Act the county agricultural agent can obtain trees for the farmer at cost of handling and shipping. Farmers can start small nurseries of their own, collecting the ripe seeds and planting them in the proper season. It is not difficult to raise trees from seed if the directions given in bulletins issued by the Federal Government and other public agencies are followed. The county agricultural agent or the reclamation project superintendent may be consulted for advice on the best way to secure trees.

Often, too, native trees and shrubs for landscaping the home grounds can be obtained for the digging along streams and coulees. It should be remembered that small trees and shrubs are more easily transplanted than larger ones. When digging out a tree, take as much of the root system as possible. Some thinning out of branches will be needed in most cases to compensate for the loss of the roots which it was impossible to get. Nature has balanced the amount of crown to the roots which supply it with food. If some of these roots are lost, the remaining ones cannot properly supply the whole top.

Certain precautions should be observed when transplanting any tree or shrub. If the stock is obtained from a nursery, it will be packed in wet moss or other suitable material. The package should be opened as soon as it is received; and if it is impossible to plant immediately, the tree should be heeled in. To heel in, a trench is dug with one side sloping and the soil moistened. The strings holding the separate bundles are cut so that the trees can be spread out along the sloped side against the moist soil. The trench is then filled with dirt, covering the trees so that only the tips of the branches are showing. The soil is tamped down firmly and thoroughly wet. This prevents the trees from drying out and they can be left this way for several days.

A good farm windbreak on fertile, but sandy soil
Top soil or crops cannot blow away on this field

When planting any tree or shrub every precaution should be taken to prevent the roots from drying. Even a few seconds of exposure to sun or wind may dry the tiny hair roots and permanently injure the tree. The roots should be kept wrapped in wet burlap and only one tree removed at a time. The hole is dug deep enough to admit all the roots without cramping and to allow the tree to set an inch or two deeper than in its original location. The roots should be straightened out to a natural growing position and tamped in firmly with damp soil, to within a few inches of the ground level. Water is poured in and allowed to seep away and then an inch or two of dry dirt added to form a mulch to prevent the moisture from evaporating and to keep the ground from baking and cracking. A depression should be left around the tree to catch the rain. When planting evergreens, the burlap can be left around the ball of earth, if, after the ball is tamped in firmly, the burlap at the top is split and the edges laid back, leaving the top of the ball open.

Trees do not do well in sod or alfalfa ground. If it is planned to start a windbreak along a field now in sod, the site of the windbreak should be plowed and left open for a year before planting is done. If trees or shrubs are to be placed on the lawn, a circle should be well spaded and the grass roots picked out. In most of the northern Great Plains States, trees do best when planted in the spring, as soon as the frost is out of the ground and before the buds begin to swell. Trees like any other plant need water and cultivation. While trees are small, windbreaks should be cared for as any row crop; they should be cultivated, kept free from weeds, and irrigated.

Farmers are beginning to realize the important part trees can play on their farms. In the past few years the trend has been toward more tree planting for both protection and beauty. With the knowledge of where to get the trees, how and when to plant them, the kind to use, and how to care for them after they are planted, every farmer should consider seriously whether his own property would not be improved by more comprehensive tree planting.

Notice of Change of Visiting Hours to the Boulder Power Plant

HEREAFTER the official guides of the Bureau of Reclamation will conduct parties to the Boulder power plant and other points of interest via the elevators in Boulder Dam between the following hours:

October 1 to May 1: 7:45 a. m. to 8:15 p. m.

May 1 to October 1: 7 a. m. to 10:15 p. m.

The first tour of each day will leave the top of the dam at the first hour shown and the last one at the second hour shown. Tours are spaced at from 15- to 30-minute intervals, and each tour lasts about 45 minutes.

Crane Prairie Dam 56 Percent Complete at End of 1939 Construction Season

CRANE PRAIRIE DAM, now under construction on the Deschutes River about 50 miles upstream from Bend, Oreg., was 56 percent complete at the end of the 1939 construction season. Abutment stripping and channel excavation were practically finished before adverse weather conditions halted work for the winter months.

Vernon Brothers of Boise, Idaho, received the contract for constructing the dam on a low bid of $98,560 and began work in late August 1939. The contract was later increased to $103,972 to include the furnishing of concrete aggregates, and 60 days was added to the allowable time for completion. The contract is to be completed in 360 days, or in August 1940. Because of the late and unusually mild fall season, the contractor has been able to go ahead rapidly, and will probably finish the contract in less than the allowed time. Practically all equipment used by the contractor is new and the construction program has been well planned and efficiently handled.

Crane Prairie Dam, the construction of which was undertaken to replace an old temporary structure built in 1922, will provide dependable storage for several existing irrigation districts. These districts have entered into Warren Act repayment contracts with the Government for the reconstruction of the dam to a reservoir capacity of 50,000 acre feet, and for the clearing of the reservoir site, at a cost of approximately $400,000.

The operation of the Crane Prairie Reservoir is to be coordinated with the operation of the Wickiup Reservoir, now under construction about 15 miles downstream for irrigation of the north unit of the Deschutes project, so as to provide maximum storage benefits for both the new project lands and the Warren Act lands already under cultivation. A contract between the interested parties, which includes the Central Oregon Irrigation District, Crook County Improvement District No. 1, Arnold Irrigation District, and the Jefferson Water Conservancy District, states that the two reservoirs shall be filled simultaneously, Crane Prairie to 30,000 acre-feet and Wickiup to 180,000 acre-feet, and that the next available water shall go to fill Crane Prairie to its full capacity. Any shortage in the amount of storage water necessary to store 180,000 acre-feet in Wickiup and 30,000 acre-feet in Crane Prairie will be prorated between the two reservoirs in the proportion that 180,000 is to 30,000 acre-feet.

At the close of the construction season (December 20) the following progress on the principal features of work had been accomplished:

Item	Quantity	Complete
	Cubic yards	*Percent*
Stripping	19,500	95
Excavation, common	12,300	90
Excavation, rock	8,260	95
Earth fill (embankment)	1,400	5
Concrete (outlet works and fish screen)	1,186	67
Total contract earnings	$58,613	56

Wildlife Restoration Week in Third Annual Meeting

By CLELAND VAN DRESSER

THE forthcoming March 17–23 will be observed throughout the Nation as the Third Annual Wildlife Restoration Week. This event is being sponsored by the National Wildlife Federation, an organization that seeks to direct the activities of some 36,000 outdoor and conservation-minded clubs and agencies in America.

For many years, according to the federation, conservation activities were scattered; there was no unity of action, and the cause of the preservation of our valuable natural resources was all but lost. In 1936, the First North American Wildlife Conference was called in Washington, D. C., by Presidential proclamation.

At that meeting, and for the first time in history, the conservationists got together and ironed out their difficulties. The sportsman from Montana began to realize that there were difficulties in the East to be overcome, while the New Englander got a good, comprehensive idea of the problems of other sections of America.

Thus unity was born and out of the conference came the National Wildlife Federation. Ever since that time the federation has labored unceasingly to preserve and restore what is left of America's priceless heritage of wildlife. Through its activities, the depredation of our country's natural resources has come to the attention of the public as never before. Gone is the false attitude of "We should worry—we have plenty of land, forests, game, and fish."

America at last realizes that she has invaded her last frontier and that superabundance of natural resources is at an end. If we are to have any animals on the land, birds in the air, and fish in our waters, a lot of things must be done. To that end the federation has sponsored the observance of National Wildlife Restoration Week, which is designed yet more forcefully to bring to the attention of the American people the plight of their wildlife.

In this announcement the federation wishes to express gratification to the Bureau of Reclamation for the work it has done and is doing in increasing the migratory waterfowl and fish population through the construction of dams and reclamation of water areas throughout the West.

More concrete information concerning the organization and the part an individual may take in aiding the Nation-wide work may be obtained by addressing the National Wildlife Federation, Normandy Building, Washington, D. C.

New Map Available

THE Bureau of Reclamation has issued the following maps which may be obtained upon application to the Bureau, payment to be made in advance by check or money order drawn to the Bureau of Reclamation. POSTAGE STAMPS ARE NOT ACCEPTABLE.

No. 39–93 (1939) Colored; size 10½ x 19½ Gila irrigation project. Price 15 cents.

No. 39–93A (1939) Colored; size 19 x 34 Gila irrigation project. Price 25 cents.

Meeting of Associated General Contractors of America

THE Associated General Contractors of America held its twenty-first annual convention in Memphis, Tenn., on February 5–8. Addresses of welcome were delivered by Gov. Prentice Cooper, of Tennessee, and Mayor Walter Chandler, of Memphis. Addresses were also delivered by Assistant Secretary of War Louis Johnson; Maj. Gen. Julian L. Schley, Chief of Engineers, U. S. Army; John P. Coyne, president, Building and Construction Trades Department, American Federation of Labor; Representative Wilburn Cartwright, of Oklahoma, Chairman of the House Roads Committee; W. E. Reynolds, Commissioner, U. S. Public Buildings Administration; Representative John J. Dempsey, of New Mexico; and John C. Page, Commissioner of Reclamation.

Commissioner Page's address on The Bureau of Reclamation Construction Program, which was delivered before the heavy and railroad contractors, will be carried in the March issue of the ERA.

H. B. Zachry, of Laredo, Tex., was installed as the new president, and M. W. Watson, of Topeka, as the new vice president to succeed Mr. Zachry.

Colorado-Big Thompson Project Visited by Colorado Society of Engineers

THE officers and directors of the Colorado Society of Engineers, all of Denver, were the guests of Porter J. Preston, supervising engineer of the Colorado-Big Thompson project, at Estes Park, Colo., on December 17, 1939. Those present were F. C. Carstarphen, consulting mining engineer, president; C. M. Lightburn, valuation engineer of the D. & R. G. Railroad, secretary; and the following directors: R. W. Lindsay, chief engineer, Mountain States Telephone Co.; C. A. Davis, chief engineer, Denver Sanitary Department; G. H. Garrett, vice president and chief engineer, Thompson Manufacturing Co.; S. O. Harper, assistant chief engineer, Bureau of Reclamation; C. H. Coberly, consulting civil engineer; Frank H. Prouty, consulting civil and mechanical engineer; and Ralph N. Tracy, sales engineer, Hardesty Manufacturing Co. Supervising Engineer Preston is vice president of the society. R. A. Klein, senior engineer, United States Bureau of Public Roads, director, and Katherine P. Wagner, executive secretary, were the two absent members.

The wives of the officers and directors were served dinner by the wives of local members of the society at the home of Mrs. Preston. After the dinner served the officers at the Hupp Hotel at Estes Park, and the one served the ladies at the home of Mrs. Preston, all guests were escorted to the east portal of the Continental Divide Tunnel, and through the office building and typical residences of the headquarters camp.

New Projects Start Construction Repayments

IT is gratifying to announce that three new projects which recently have been placed in operation by the Bureau of Reclamation, made their first payments on construction charges during the month of December 1939.

These are the Burnt River project in Oregon, begun in January 1936 and completed with expenditure of approximately $600,000, on which the Burnt River Irrigation District paid $7,500 as its first installment; the Frenchtown project in Montana, begun in February 1936 and completed at a cost of approximately $295,000, on which the Frenchtown Irrigation District paid $625 as the first installment of a series which gradually will increase in size; and the Ephraim Division of the Sanpete project in Utah, begun in September 1935 and completed for approximately $190,000, on which the Ephraim Irrigation Co. paid the first $500 of an installment of $2,375, the remainder of which will be forwarded in February.

Under the reclamation law, projects constructed by the Bureau of Reclamation must repay the cost of the construction in 40 years. The Burnt River project at Unity, Oreg., serves 16,801 acres by storing water in Unity Reservoir. The Ephraim division of the Sanpete project serves 6,755 acres by diverting water from Cottonwood Creek into the Great Basin near Ephraim, Utah. The Frenchtown project serves 4,878 acres in the vicinity of Frenchtown, Mont.

These three comparatively small projects, built with P. W. A. allotments, not only are usefully employed by the communities which they were intended to serve, but they now have begun the orderly repayment to the Government of the money expended in their construction. They have taken their places with many older reclamation projects already in the repaying class. Commissioner Page states that he is particularly pleased with this action of the water users in meeting their first obligation and that he looks forward to the time when full repayment will have been made. The irrigation works which have been constructed will still be serving these people at that time, and will be useful, even then, for many, many years to come.

Exhibit Building To Be Erected at Boulder Dam

ACCORDING to plans recently completed, there will be constructed at Boulder Dam an exhibit building for the convenience of the hundreds of thousands of tourists, the number of such visitors having increased from about 300,000 the first year to a maximum of 600,000.

It is expected that the building will be ready for use next July. It will contain rest rooms, a room for the use of guides stationed at the dam, and a hall to display a model of Boulder Canyon. The building will be located on the Nevada side of the Colorado River near the abutment of the dam against the precipitous wall of Black Canyon, and will be air-conditioned for the comfort of the many thousands who visit the dam during the summer months.

Regular tours through Boulder Dam are conducted by the Bureau of Reclamation, and the exhibit house will be an added feature of the tour. The model will show the relationship of the dam to other features of the development of the Colorado River, such as Parker Dam, the Colorado River Aqueduct, Imperial Dam, and the All-American Canal.

Lake Mead, the gigantic reservoir created by Boulder Dam, is being operated as a national recreational area by the National Park Service, with regularly scheduled sightseeing trips through the colorful canyons of the Colorado River, which includes Black Canyon immediately above the dam.

Adoption recently of new regulations designed to safeguard the public while visiting Boulder Dam and the dam itself gave rise to reports that the public would not be welcome at the structure during the coming year. Commisisoner of Reclamation Page states that the Bureau's plans are quite the reverse, and that visitors will not only be welcome but additional facilities represented by the exhibit building are expected to be available for them.

The new rules now in force at the dam simply provide for definite visiting hours for the convenience of the guide force, the prevention of irregular entry to the structure, and will prevent private boats from entering that portion of Black Canyon immediately above the dam. The regular scheduled boat tours will make the same trips as in the past.

Redhead Duck

Not so long ago the Redhead Duck, one of our most popular and valuable game birds, seemed flying the trail to oblivion, winged by the Passenger Pigeon and Heath Hen.

This bird was particularly threatened, for the drought hit many of his principal breeding and nesting areas. Huge sections of the Dakotas, Montana, Utah, and other Western States went arid, and the Redhead, once fairly populous in these regions, began to disappear.

In fact, so grave did the situation become, that in 1936, the Bureau of Biological Survey placed the Redhead on the "fully protected" list, along with Canvasback, Snow Geese, Trumpeter Swan, Wood Duck, and other species.

Red head

Today the picture is not quite so gloomy. Legal hunting of Redheads is once more allowed, and the birds are staging a comeback. This happy situation is due in no small measure to the activities of the Bureau of Reclamation, which has reclaimed many water areas throughout the West, thus giving the harrassed Redheads a chance to breed and nest again.—*Cleland van Dresser.*

Shasta Dam

SHASTA DAM will rank as second highest concrete masonry dam in the world after Boulder, and second largest in bulk of masonry concrete after Grand Coulee. Its spillway will create a waterfall three times higher than Niagara.

Duke University Now Has College of Engineering

IN accordance with a resolution adopted by the board of trustees of Duke University, the Division of Engineering, which was administered as part of Trinity College, was reorganized into the College of Engineering of Duke University. W. H. Hall, professor of civil engineering and chairman of the division of Engineering, has been appointed dean of engineering. Three curricula in engineering, civil, electrical, and mechanical, are offered.

Annual Report of the Secretary of the Interior, Fiscal Year 1939

THE annual report of the Secretary of the Interior covering the operations of the several Interior Department bureaus for the fiscal year ended June 30, 1939, is now available and may be obtained from the Superintendent of Documents, Government Printing Office, Washington, D. C., at 75 cents a copy (paper bound).

This 458-page document is a comprehensive report of the Secretary of the Interior to the President, and represents considerable activity and progress throughout the Department.

Pages 194-231 contain the thirty-eighth annual report of the Bureau of Reclamation under Commissioner John C. Page. The transformation of broad stretches of arid and semiarid regions in the West into valuable agricultural lands, watered by a comprehensive system of reclamation projects, development of hydroelectric power for private and community use, and economic advancement of the people themselves were included in the year's work.

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CUT ALONG THIS LINE

Commissioner,
Bureau of Reclamation,
Washington, D. C.

(Date)..................................

Sir: I am enclosing my check [1] (or money order) for $1.00 to pay for a year's subscription to The Reclamation Era.

Very truly yours,

February 1940.

(Name)..................................

(Address)..................................

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[1] Do not send stamps.

Note.—36 cents postal charges should be added for foreign subscriptions.

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Projects under construction or operated in whole or in part by the Bureau of Reclamation

Project	Office	Official in charge		Chief clerk	District counsel	
		Name	Title		Name	Address
All-American Canal	Yuma, Ariz	Len J. Foster	Constr. engr	J. C. Thrailkill	R. J. Coffey	Los Angeles, Calif.
Belle Fourche	Newell, S. Dak	F. C. Youngblutt	Superintendent	J. P. Siebeneicher	W. J. Burke	Billings, Mont.
Boise	Boise, Idaho	R. J. Newell	Constr. engr	Robert B. Smith	B. E. Stoutemyer	Portland, Oreg.
Boulder Canyon [1]	Boulder City, Nev	Irving C. Harris	Director of power	Gail H. Baird	R. J. Coffey	Los Angeles, Calif.
Buffalo Rapids	Glendive, Mont	Paul A. Jones	Constr. engr	Edwin M. Benn	W. J. Burke	Billings, Mont.
Buford-Trenton	Williston, N. Dak	Parley R. Neeley	Res. engr	Robert L. Neuman	W. J. Burke	Billings, Mont.
Carlsbad	Carlsbad, N. Mex	L. E. Foster	Superintendent	E. W. Shepard	H. J. S. Devries	El Paso, Tex.
Central Valley	Sacramento, Calif	W. R. Young	Supervising engr	E. R. Mills	R. J. Coffey	Los Angeles, Calif.
Shasta Dam	Redding, Calif	Ralph Lowry	Constr. engr		R. J. Coffey	Los Angeles, Calif.
Friant division	Friant, Calif	R. B. Williams	Constr. engr		R. J. Coffey	Los Angeles, Calif.
Delta division	Antioch, Calif	Oscar G. Boden	Constr. engr		R. J. Coffey	Los Angeles, Calif.
Colorado-Big Thompson	Estes Park, Colo	Porter J. Preston	Supervising engr	C. M. Voyen	J. R. Alexander	Salt Lake City, Utah.
Colorado River	Austin, Tex	Ernest A. Moritz	Constr. engr	William F. Sha	H. J. S. Devries	El Paso, Tex.
Columbia Basin	Coulee Dam, Wash	F. A. Banks	Supervising engr	C. B. Funk	B. E. Stoutemyer	Portland, Oreg.
Deschutes	Bend, Oreg	D. S. Stuver	Constr. engr	Noble O. Anderson	B. E. Stoutemyer	Portland, Oreg.
Gila	Yuma, Ariz	Leo J. Foster	Constr. engr	J. C. Thrailkill	R. J. Coffey	Los Angeles, Calif.
Grand Valley	Grand Junction, Colo	W. J. Chiesman	Superintendent	Emil T. Ficenec	J. R. Alexander	Salt Lake City, Utah.
Humboldt	Reno, Nev	Chas. S. Hale	Constr. engr		J. R. Alexander	Salt Lake City, Utah.
Kendrick	Casper, Wyo	Irvin J. Matthews	Constr. engr.[2]	George W. Lyle	W. J. Burke	Billings, Mont.
Klamath	Klamath Falls, Oreg	B. E. Hayden	Superintendent	W. I. Tingley	B. E. Stoutemyer	Portland, Oreg.
Milk River	Malta, Mont	H. H. Johnson	Superintendent	E. E. Chabot	W. J. Burke	Billings, Mont.
Fresno Dam	Havre, Mont	H. V. Hubbell	Constr. engr	E. E. Chabot	W. J. Burke	Billings, Mont.
Minidoka	Burley, Idaho	Stanley R. Marean	Superintendent	G. C. Patterson	B. E. Stoutemyer	Portland, Oreg.
Minidoka Power Plant	Burley, Idaho	Samuel A. McWilliams	Resident engr		B. E Stoutemyer	Portland, Oreg.
Moon Lake	Provo, Utah	E. O. Larson	Constr. engr	Francis J. Farrell	J. R. Alexander	Salt Lake City, Utah.
North Platte	Guernsey, Wyo	C. F. Gleason	Supt. of power	A. T. Stimpfig	W. J. Burke	Billings, Mont.
Ogden River	Provo, Utah	E. O. Larson	Constr. engr	Francis J. Farrell	J. R. Alexander	Salt Lake City, Utah.
Orland	Orland, Calif	D. L. Carmody	Superintendent	W. D. Funk	R. J. Coffey	Los Angeles, Calif.
Owyhee	Boise, Idaho	R. J. Newell	Constr. engr	Robert B. Smith	B. E. Stoutemyer	Portland, Oreg.
Parker Dam Power	Parker Dam, Calif	E. C. Koppen	Constr. engr	George B. Snow	R. J. Coffey	Los Angeles, Calif.
Pine River	Vallecito, Colo	Charles A. Burns	Constr. engr	Frank E. Gawn	J. R. Alexander	Salt Lake City, Utah.
Provo River	Provo, Utah	E. O. Larson	Constr. engr	Francis J. Farrell	J. R. Alexander	Salt Lake City, Utah.
Rio Grande	El Paso, Tex	L. R. Fiock	Superintendent	H. H. Berryhill	H. J. S. Devries	El Paso, Tex.
Elephant Butte Power Plant	Elephant Butte, N. Mex		Resident engr	H. H. Berryhill	H. J. S. Devries	El Paso, Tex.
Riverton	Riverton, Wyo	H. D. Comstock	Superintendent	C. B. Wentzel	W. J. Burke	Billings, Mont.
Sanpete	Provo, Utah	E. O. Larson	Constr. engr	Francis J. Farrell	J. R. Alexander	Salt Lake City, Utah
Shoshone	Powell, Wyo	L. J. Windle	Superintendent [2]	L. J. Windle [2]	W. J. Burke	Billings, Mont.
Heart Mountain division	Cody, Wyo	Walter F. Kemp	Constr. engr	L. J. Windle [2]	W. J. Burke	Billings, Mont.
Sun River	Fairfield, Mont	A. W. Walker	Superintendent		W. J. Burke	Billings, Mont.
Truckee River Storage	Reno, Nev	Charles S. Hale	Constr. engr		J. R. Alexander	Salt Lake City, Utah.
Tucumcari	Tucumcari, N. Mex	Harold W. Mutch	Engineer	Charles L. Harris	H. J. S. Devries	El Paso, Tex.
Umatilla (McKay Dam)	Pendleton, Oreg	C. L. Tice	Reservoir supt		B. E. Stoutemyer	Portland, Oreg.
Uncompahgre: Repairs to canals	Montrose, Colo	Denton J. Paul	Engineer	Ewalt P. Anderson	J. R. Alexander	Salt Lake City, Utah.
Upper Snake River Storage [3]	Ashton, Idaho	I. Donald Jerman	Constr. engr.[2]	Emmanuel V. Hillius	B. E. Stoutemyer	Portland, Oreg.
Vale	Vale, Oreg	C. C. Ketchum	Superintendent		B. E. Stoutemyer	Portland, Oreg.
Yakima	Yakima, Wash	J. S. Moore	Superintendent	Conrad J Ralston	B. E. Stoutemyer	Portland, Oreg.
Rosa division	Yakima, Wash	Charles E. Crownover	Constr. engr	Alex S. Harker	B. E. Stoutemyer	Portland, Oreg.
Yuma	Yuma, Ariz	C. B. Elliott	Superintendent	Jacob T. Davenport	R. J. Coffey	Los Angeles, Calif.

[1] Boulder Dam and Power Plant.

[2] Acting.

[3] Island Park and Grassy Lake Dams.

Projects or divisions of projects of Bureau of Reclamation operated by water users

Project	Organization	Office	Operating official		Secretary	
			Name	Title	Name	Address
Baker (Thief Valley division) [1]	Lower Powder River irrigation district	Baker, Oreg	A. J. Ritter	President	F. A. Phillips	Keating.
Bitter Root [4]	Bitter Root irrigation district	Hamilton, Mont	G. R. Walsh	Manager	Elsie H. Wagner	Hamilton.
Boise [1]	Board of Control	Boise, Idaho	Wm. H. Tuller	Project manager	L. P. Jensen	Boise.
Boise [1]	Black Canyon irrigation district	Notus, Idaho	W. H. Jordan	Superintendent	L. M. Watson	Caldwell.
Burnt River	Burnt River irrigation district	Huntington, Oreg	Edward Sullivan	President	Harold H. Hursh	Huntington.
Frenchtown	Frenchtown irrigation district	Frenchtown, Mont	Edward Donlan	President	Ralph P. Schaffer	Huson.
Grand Valley, Orchard Mesa [3]	Orchard Mesa irrigation district	Grand Jctn., Colo	C. W. Tharp	Superintendent	C. J. McCormich	Grand Jctn.
Huntley [4]	Huntley irrigation district	Ballatine, Mont	E. E. Lewis	Manager	H. S. Elliott	Ballatine.
Hyrum [3]	South Cache W. U. A.	Wellsville, Utah	B. L. Mendenhall	Superintendent	Harry C. Parker	Logan.
Klamath, Langell Valley [1]	Langell Valley irrigation district	Bonanza, Oreg	Chas. A. Revell	Manager	Chas. A. Revell	Bonansa.
Klamath, Horsefly [1]	Horsefly irrigation district	Bonanza, Oreg	Henry Schmor, Jr	President	Dorothy Eyers	Bonansa.
Lower Yellowstone [4]	Board of Control	Sidney, Mont	Axel Persson	Manager	Axel Persson	Sidney.
Milk River: Chinook division [4]	Alfalfa Valley irrigation district	Chinook, Mont	A. L. Benton	President	R. H. Clarkson	Chinook.
	Fort Belknap irrigation district	Chinook, Mont	H. B Bonefright	President	L. V. Bogy	Chinook
	Zurich irrigation district	Harlem, Mont	C. A. Watkins	President	H. M. Montgomery	Chinook.
	Harlem irrigation district	Harlem, Mont	Thos. M. Everett	President	Geo. H. Tout	Harlem.
	Paradise Valley irrigation district	Zurich, Mont	R. E. Musgrove	President	J. F. Sharples	Zurich.
Minidoka: Gravity [1]	Minidoka irrigation district	Rupert, Idaho	Frank A. Ballard	Manager	O. W. Paul	Rupert.
Pumping	Burley irrigation district	Burley, Idaho	Hugh L. Crawford	Manager	Frank O. Redfield	Burley.
Gooding [1]	Amer. Falls Reserv. Dist. No. 2	Gooding, Idaho	S. T. Baer	Manager	Ida M. Johnson	Gooding.
Newlands [3]	Truckee-Carson irrigation district	Fallon, Nev	W. H. Wallace	Managor	H. W. Emery	Fallon.
North Platte: Interstate division [4]	Pathfinder irrigation district	Mitchell, Nebr	T. W. Parry	Manager	Flora K. Schroeder	Mitchell.
Fort Laramie division [4]	Gering-Fort Laramie irrigation district	Gering, Nebr	W. O. Fleenor	Superintendent	C. C. Klingman	Gering.
Fort Laramie division [4]	Goshen irrigation district	Torrington, Wyo	Floyd M. Roush	Superintendent	Mary E. Harrnch	Torrington.
Northport division [4]	Northport irrigation district	Northport, Nebr	Mark Iddings	Manager	Mabel J. Thompson	Bridgeport.
Ogden River	Ogden River W. U. A.	Ogden, Utah	David A. Scott	Superintendent	Wm. P. Stephens	Ogden, Utah.
Okanogan [1]	Okanogan irrigation district	Okanogan, Wash	Nelson D. Thorp	Manager	Nelson D. Thorp	Okanogan.
Salt Lake Basin (Echo Res.) [3]	Weber River Water Users' Assn	Ogden, Utah	D. D. Harris	Manager	D. D. Harris	Layton.
Salt River [2]	Salt River Valley W. U. A	Phoenix, Ariz	H. J. Lawson	Superintendent	F. C. Henshaw	Phoenix.
Shoshone: Garland division [4]	Shoshone irrigation district	Powell, Wyo	Paul Nelson	Acting Irri. supt	Harry Barrows	Powell.
Frannie division [4]	Deaver irrigation district	Deaver, Wyo	Floyd Lucas	Manager	R. J. Schwendiman	Deaver.
Strawberry Valley	Strawberry Water Users' Assn	Payson, Utah	S. W. Grotegut	President	E. G. Breeze	Payson.
Sun River: Fort Shaw division [4]	Fort Shaw irrigation district	Fort Shaw, Mont	C. L. Bailey	Manager	C. L. Bailey	Fort Shaw.
Greenfields division [4]	Greenfields irrigation district	Fairfield, Mont	A. W. Walker	Manager	H. P. Wangen	Fairfield.
Umatilla: East division [1]	Hermiston irrigation district	Hermiston, Oreg	E. D. Martin	Manager	Enos D. Martin	Hermiston.
West division [1]	West Extension irrigation district	Irrigon, Oreg	A. C. Houghton	Manager	A. C. Houghton	Irrigon.
Uncompahgre [3]	Uncompahgre Valley W. U. A	Montrose, Colo	Jesse R. Thompson	Manager	H. D. Calloway	Montrose.
Yakima, Kittitas division [1]	Kittitas reclamation district	Ellensburg, Wash	G. C. Hughes	Acting manager	C. L. Sterling	Ellensburg.

[1] B. E. Stoutemyer, district counsel, Portland, Oreg.

[2] R. J. Coffey, district counsel, Los Angeles, Calif.

[3] J. R. Alexander, district counsel, Salt Lake City, Utah.

[4] W. J. Burke, district counsel, Billings, Mont.

Important investigations in progress

Project	Office	In charge of—	Title
Colorado River Basin, sec. 15 (Colo., Wyo., Utah, N. Mex.)	Denver, Colo	E. B. Debler	Senior engineer.
Fort Peck Pumping (Mont., N. Dak.)	Denver, Colo	W. G. Sloan	Engineer.
Missouri River Pumping (N. Dak., S. Dak.)	Denver, Colo	W. G. Sloan	Engineer.
Yellowstone Basin (Mont.)	Helena, Mont	F. V. Munro	Engineer.
Big Horn Basin (Mont., Wyo.)	Denver, Colo	W. G. Sloan	Engineer.
Cache and Beaver Creek, North Canadian (Okla.)	Denver, Colo	A. N. Thompson	Engineer.
Arkansas Valley (Colo., Kans.)	Denver, Colo	A. N. Thompson	Engineer.
Challis (Salmon River)	Salmon City, Idaho	O. L. Kime	Associate Engineer
Robert Lee (Tex.)	Austin, Tex	E. A. Moritz	Construction engineer.
Duchesne-Sevier (Utah)	Salt Lake City, Utah	E. G. Nielsen	Engineer.
Williams, Hassayampa, Little Colorado (Ariz.)	Phoenix, Ariz	Major O. Simons	Associate engineer.

Issued monthly by the Bureau of Reclamation, Department of the Interior, as approved by the Director of the Budget. SALLIE A. B. COE, *Editor*.

THROUGH THE CAMERA LENS

DYNAMITE skyrockets the first earth broken at Friant damsite as 50,000 persons look on

FOG, like a great smokescreen, low over Grand Coulee Dam this time of year

SPARKS FLY
A welder in the shops of the All American Canal project.

OVER THE HILLS TO SHASTA 9 miles away runs this belt conveyor

AIR PROPELLED this boat skims the rapids and shallow water below Boulder Dam

27.5

THE RECLAMATION ERA

MARCH 1940

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Under Secretary Wirtz on Power

DURING the course of an early spring inspection tour of Interior Department projects on the Pacific coast and in the Northwest, Under Secretary of the Interior Alvin J. Wirtz addressed chambers of commerce luncheons at Portland and at Spokane. In both places he dwelt upon the power policy of the Department with regard to power projects under its administration. Of particular interest to those interested in reclamation was the Secretary's statement at Spokane following his visit to the Grand Coulee Dam:

"It is logical that States and communities cooperate with the Federal Government in the development of large projects such as Bonneville and Grand Coulee. Such a partnership is founded on a recognition of interdependence and mutual trust. It presupposes an identity of interest and a common goal. We are securing the rights of our States and communities against the ravages of nature and absentee control.

"The Federal Government has shown the extent of its trust in the people of the Northwest in establishing the Columbia River projects as great national interests. The President did not lay down any conditions as a prerequisite to aiding in the development of these projects. He had confidence in the people of the Northwest and faith in their willingness to cooperate to make these national projects monuments of productive wealth of which both the Nation and the Northwest could be proud.

"The objectives of these projects were to control the waters of the Columbia so as to irrigate more than a million acres of land and provide opportunity for resettlement, and at the same time make available for the widest possible use electric energy at the lowest possible cost. Congress provided for the generation of power at these great dams by and at the risk of the Federal Government. It provided for the transmission of power from these dams to centers of distribution. These things the Federal Government is doing at cost and it is up to you people to determine how and by whom this power shall be distributed.

"In connection with the Grand Coulee project the Congress with foresight provided an antispeculation law. No man may enrich himself by gambling in a resource whose value is enhanced by the Federal Government. The acres which are made fertile by the waters impounded by this great project may not be sold and resold at ever mounting cost merely by taking advantage of the effort of the Federal Government.

"Although no antispeculation bill was passed with regard to electric power, nonetheless, the Congress in many ways has stated its policy directly, and certainly by implication in this particular case it is evident that the Congress does not propose that there shall be speculation in electric power. The people of the United States jointly are generating this power for the benefit of the people of the Northwest—for home use, for commerce, and for industry. The desire, then, is to distribute this electricity to the largest number of persons at the lowest possible cost so that its benefits may be spread and it may be a potent factor in helping raise and maintain the standard of living which we want to have.

"As I say, the manner of the distribution is for decision by the people in the area. But the people have a right to demand that the benefits from this power shall be theirs and not that of absentee managers. Furthermore, I think it is the duty of all Federal officials who are responsible for the construction and operation of these projects to let the people know that they have the right to have the water from their rivers utilized by their dams transmitted over their lines and brought to their homes, farms, stores, or factories, over their own distribution systems.

"It is your responsibility in this partnership with the Federal Government to see that the savings made possible by this project result in increased purchasing power in your region."

PRICE
ONE
DOLLAR
A YEAR

THE RECLAMATION ERA

VOLUME 30 • MARCH 1940 • NUMBER 3

The Bureau of Reclamation Construction Program

By JOHN C. PAGE, *Commissioner of Reclamation*[1]

I COME before the heavy construction section of the Associated General Contractors today at your annual meeting for the third time. The first time I addressed you I talked generally about the work of the Bureau of Reclamation and the part the contractors of America play in it. On my second appearance I sounded a few warnings. Today I want just briefly to sum things up.

Every big contractor in the business now should know something about reclamation. I think we have had bids from most of you in the past year or two, and those of you who kept your pencils sharp enough have probably done some of our work or are doing some of it now. If you are not, you had better look into it, because Reclamation construction in the West is the biggest thing going on out there at this time. We have $115,398,235 of contracts in force at this minute, counting only major jobs.

Please do not misunderstand me. The business of building, which is very exciting and very important, if it is done well, is not our sole concern. A dam should never be looked upon as a monument, for if it is not useful and if it does not bring a full measure of benefits to mankind it should not be built at all. A canal system is something more than a job for the exercise of engineering skill, and a power plant is not just a house to protect some carefully constructed machinery. The Bureau of Reclamation is building projects which make new homes to add to hundreds of thousands we have already founded by irrigating the desert, and new opportunities for additional thousands to add to the million people who are now making decent livings in areas already developed by us.

Reclamation and the Contractor

But this is a meeting of contractors, so let us talk for the moment of the building of these dams and these canals and these power plants. First I want to say that our relationships with the contractors at work on our projects have been on the whole very good. Last year I pointed out the dangers which are inherent in a couple of practices which were then evident. There was a tendency of the contractors to join together to bid as a combination on big jobs. When the job is big enough, this probably is necessary. These combinations, however, were not always completely disintegrated in bidding for work that could be handled easily by a single firm. There was also the practice of some contractors dashing out to hire a high-priced lawyer the moment an award was received in order that a series of claims could be developed against the Government. Extension of these practices, I said, might lead to serious consequences from the point of view of the contractors. In return for offering its work on the open market the Government is certainly entitled to truly competitive bidding. In return for the award of a contract made to the low bidder, the Government and other contractors who may have missed getting the work by only a few dollars, have a right to expect the successful bidder to do the work he has won without inching up his compensation by legal "fenageling." I was not saying that all claims are unjustified, but if the time ever comes when each contract means a long battle in the Court of Claims, it will cost so much for attorney hire that we will have to try something new or close up shop. We try to be just and reasonable and expect the contractor to be the same.

I am happy to report that there were but few instances in the past year of these objectionable practices.

Let us review, for a moment, the history of the relationship between the Bureau of Reclamation and the contracting industry. At the outset of our work in 1902 we adopted the contract method. We had a great number of suspended contracts, and were forced to take over plant and equipment. Soon we found when undertaking work in places difficult to reach that no bids were received. This meant we were obliged to do these jobs ourselves, and to build up a construction force (and it was a good one, too) in order to get the work done. Later, work was done with Government forces to keep our organization busy. During this time we did work that the contractors would have been glad to have had. This phase extended to 1925. In these 23 years we spent about $160,000,000 for construction. Of this amount about $60,000,000 was for Government force construction, $40,000,000 for construction by contract, $50,000,000 for materials and supplies, and $10,000,000 for rights-of-way.

Policy of Contracting Work Began in 1925

In 1925 a policy of letting all possible work by contract on competitive bidding was adopted by the Department of the Interior. This policy extended to the Bureau of Reclamation. Since then very little construction work has been done by Government forces. Between 1933 and 1939 a total of $290,000,000 of construction was done on Bureau of Reclamation projects. Of this total only $2,567,000, or less than 2 percent was done by Government forces. It is a notable commentary on the reliability of the contractor today to state that since 1932 we have not experienced a suspended contract.

Work Sometimes Done by Government Forces

The Bureau of Reclamation prefers to do its work by contract. It saves us the difficult task of expanding and contracting our forces to meet changing phases of our jobs. We are well organized to supervise contract work. Our results under the system are excellent. If a job is tedious or apt to be subject to interruptions and for those or other reasons is unattractive to the contracting industry, we do not hesitate to do it ourselves. If the bids received are out of line with our estimates of the cost of the work—and we make very careful estimates backed up by long and varied experience—we do not award a contract. I must add, however, that we have not had to do any job for want of fair bids in recent years. Recently, however, we have had to readvertise a long tunnel job and we may readvertise it once more, since the matter still is unsettled. We may have to do this work with Government forces. The risks encountered in undertaking work on a long tunnel apparently frighten the contractors, although our specifications were drawn to eliminate most of these risks. If the Government has to guarantee such a job completely, then the bids will have to be within our estimates or we will do the work ourselves. I see no other line of action available to us which would be in the public interest.

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[1] Address delivered in Memphis, Tenn., February 7, before the Heavy Construction and Railroad Contractors Division, at the twenty-first annual convention of the Associated General Contractors of America.

Our interest in these matters is the public interest. When fair prices are offered (and they usually are) by the contractors, the contractors do the work.

I have heard two types of complaints about our methods. Some, who are not well informed, complain that on some job which they cannot identify, the contractor made an unreasonable profit. These complaints are founded on rumors. We expect the contractors to make a reasonable profit. We know that some have taken losses in doing work for us. Some have been lucky, and have not had the interference from weather or other bugaboos which was reasonably to be expected, and have done better than they anticipated. Frankly, I believe a few have made more money than we anticipated they should make on the work they undertook. In most instances or suspected instances of this sort, however, the contractor came up with a new method, an ingenious device, or an improved procedure that was wholly his which earned his take for him. The Government got the work done for what was a fair price. Moreover, once the contractor used his brilliant idea and proved it would work, the idea was taken up by others and the Government got the benefit of it on its next similar contract. I am not revealing a secret when I say we would base our next estimate on the use of the new development.

Improved Construction Methods

Introduction of belt conveyors has saved money in certain types of work. We anticipate the use of belt conveyors when we consider them adaptable in estimating costs now. The best case in point, however, probably is found on the All-American Canal. This big ditch has been dug mostly through silt. At no time did we figure that the work would be costly, but we were amazed at the low figure per cubic yard of the successful bid on one of the early contracts. Something entirely new in irrigation canal excavation was being proposed by the contractor. He proposed to bring to the job a giant dragline of a type used previously principally in levee work along the Mississippi River. It worked, and it set the pace for the construction of the whole canal. The Government saved a few million dollars.

I started to say there are two types of complaints received. I have discussed but one. The other type is that received from the contractors themselves. In our offices, to hear you men talk, one would judge most of you were only half a step ahead of the sheriff because of the amount of money you are losing each day on that dam, on that bridge, or that canal, or that tunnel which you are building for us. Sometimes it sounds like a man with bobtailed straight trying to convince another with backed-up aces that he should fold his hand.

I remember a very solemn gathering. About half a dozen responsible Bureau of Reclamation engineers were wearing their best poker faces while a contractor friend of mine was putting on an act in an effort to get some provision in the specifications relaxed, or an interpretation changed. This friend of mine walked up and down wringing his hands. He spoke of his dependent mother. He thought the impending disaster would kill him and feared for the future of his widow and little daughter. He knew we would not be unreasonable, and guessed some messenger had delivered the wrong paper to him. He wept a little. Then he stopped and looked around the circle of stony faces. He sighed and turned to me, saying calmly, "I guess it didn't go over so good," put on his hat, and laughed with us as he went back to work.

All I am trying to say is that the specifications are carefully drawn by men with lots of experience, and they should be read by the contractor before as well as after he does his bidding on the job.

There have been half a dozen instances in recent months in which bids have been submitted by contractors who immediately said that they had made mistakes. In several cases it was obvious to us that their bids were far too low. It is difficult to understand how a serious business like that of presenting a bid on important work, all duly accompanied by an ironclad bond, can be carelessly done. I have no alternative but to believe that now and then it is carelessly done. It is a distasteful task to insist on awarding a contract when the bidder is protesting he wrote down the wrong figures and will go broke if he has to do the work. The law, however, is perfectly clear on what we must do. If all bidders would check their bids more carefully before submitting them some real tragedies could be avoided. I sometimes suspect that many bids are made up on the backs of old envelopes in the smoking cars of trains spee ing contractors to an opening at 59 minut past the eleventh hour. What the Gover ment gains by acceptance of a hopeless bid poor compensation for the grief which go with it; grief for the contractor and his m and grief for us who have to inspect the wo and deal with the victims.

No Large Jobs in Immediate Prospect

I suspect all of you are interested in wh work we plan to put on the market this yea For the most part, our present expectatio are that the larger part of the funds whi will be supplied to the Bureau will be requir to carry on work already under contra There are no very large new jobs in prosp at the moment. Our appropriation bill h not been reported in the House of Represen atives, but the $44,000,000 which was reco mended in the Budget for construction in t fiscal year 1941 will just about carry on wh is now under way. There will be, of cour a good many contracts let for sizable jobs, this sum is appropriated, but not so many during each of the past 6 years. There w be considerable canal work and work medium-sized structures, but the volume new work on dams will be small. The pe has passed of the extremely heavy constr tion, so far as new work on our program presently constituted is concerned. One pr ect is an exception, the Colorado-Big Thom son project in Colorado, on which a number important features have not as yet b started.

There are two important new developme which may have an important bearing on programs in the future in which you will interested. The first of these to which want to call attention is the author recently granted to include consideration flood control in planning large, multiple-p pose reclamation dams and reservoirs. Un an agreement with the Corps of Engineers the War Department, we jointly review d obtained in preliminary investigations, each organization advises the other in special field. By this method, it is belie that construction and operation of multi purpose dams and projects will be placed wi they logically belong with the agency ha the principal interest and responsibility. cept for this innovation, there would be stant danger of duplication of effort in preliminary investigations made in the w ern area to which our work is confined, a possibility that some valuable func might be slighted in projects underta Our relationships with the Corps of Engin have been and remain most cordial. We work together.

Great Plains Program

The second important development is in which considerable interest has been

(*Continued on page 65*)

Origin of Names of Projects and Project Features in Reclamation Territory[1]

WITH this issue of the ERA we are beginning a series of articles the publication of which has been suggested by the many inquiries received in the Washington Office of the Bureau of Reclamation regarding the varied and, in many cases, peculiar names of our projects and their several respective features. We start the series with the Boise, Owyhee, and Belle Fourche projects. Other articles in the series, will appear from time to time.

In the case of a number of the projects, the information has been obtained from local sources. The construction engineer in charge of the Boise and Owyhee projects advises that the statements made concerning those projects must not be accepted as absolutely factual, but as the best available at this time, based on written history, on what has been related by the early settlers or their descendants, or on popular legends.

Arrowrock Dam and Reservoir holding maximum storage

Boise Project, Idaho

The Boise project, located in southwestern Idaho and eastern Oregon adjacent to the city of Boise, was authorized for construction on March 27, 1905. Its principal engineering structure, Arrowrock Dam on the Boise River, was completed in 1916 and at that time took rank as the highest dam in the world.

Boise.—The word Boise originated in 1834 when a party of French Canadians, part of an exploring and trapping expedition led by Captain Bonneville, a United States Army officer, pitched camp on the mesa overlooking the site where the city of Boise now stands, and looked down upon the valley through which flowed a beautiful river between ranks of poplars or cottonwoods. They had traveled for many days through the dust and sagebrush in the heat of summer, and had not seen a tree for hundreds of miles. When they saw the trees along the river they exclaimed: "Les bois, les bois! Voyez les bois!" meaning "The woods, the woods! See the woods!"

Arrowrock.—Arrow Rock at the north abutment of the present dam probably got its name from the great number of Indian arrowheads found at its base. It is supposed that Indians, in the spirit of contest or to test their skill, shot arrows high in the air against the steep sides of Arrow Rock. Another contention is that the rock was named for its arrowhead shape, while still another is that Indian rock writings including a large arrow pointing upstream were found when excavation was started for the dam. The great change wrought by the construction of the dam prevents substantiation of any of these theories.

Payette.—The Payette River was named for Francis Payette who in 1818 led a small party of Hudson Bay trappers along this stream to catch beaver. He was afterward the trader in charge at Fort Boise for the Hudson Bay Co.

Weiser.—The Weiser River was named in 1818 for Jacob Weiser, a Hudson Bay trapper, who trapped for beaver along this stream.

Nampa.—The word Nampa was derived from the Shoshoni Indian word "nampuh" meaning "big foot," and more particularly from Chief Nampuh, war chief of the Wihinast tribe, a branch of the Shoshonis, who lived along the Boise River. He is reputed to have had a foot 17½ inches long and 6 inches wide, and to have been a veritable superman in strength and stature. He was an outlaw and was killed in 1868 by a highwayman.

Owyhee Project, Oregon-Idaho

Owyhee.—There are several theories regarding the origin of the name Owyhee. Histories tell us that this name was given the Sandwich Islands in 1778 by Capt. James Cook, an English navigator, but that the word is now spelled "Hawaii." In 1819 Donald Mackenzie outfitted three natives of the Hawaiian Islands—Owyhees they were called—who were employed by the Hudson Bay Co. to trap the stream for beaver during the winter. Indians, probably from the Shoshoni Tribe, found and murdered the trappers, since which time the stream has been called the Owyhee River. Although some say that the word is a corruption of Hawaii or Oahu, one of the Hawaiian Islands, it is generally agreed that the word originated with trappers who were brought in from the Hawaiian Islands.

Malheur.—The name Malheur was used by Peter Skene Ogden, a Hudson Bay Co. trader, who made an expedition into the Snake River country in 1825–26. In Ogden's journal appears the following entry: "Tuesday, February 14, 1826. We encamped on River au Malheur (French for evil hour or misfortune) so called on account of goods and furs concealed here, discovered, and stolen by the natives." Ogden was accompanied by French-Canadian hunters.

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[1] A compilation of data furnished by the field offices of the Bureau of Reclamation.

Dead Ox Flat.—A pioneer family in a prairie schooner drawn by a team of oxen were making their difficult way overland. The oxen were footsore and weary and one developed a bad limp. Camp was pitched on this flat and during the night the lame animal died. A passing cowboy gave assistance, and when he came back that way again he noticed range cattle grazing near the dead animal. Later he met another cowboy who was looking for the cattle and directed him by the dead ox along the trail. Soon this dead ox became a landmark for directing travel and the flat took the name Dead Ox Flat.

Mitchell Butte.—Mitchell Butte got its name from a pioneer cattle rancher who lived near the butte. He is reported to have engaged in some questionable practices in obtaining cattle and was run out of the country by the other ranchers in the vicinity.

Succor Creek.—The origin and even the present-day spelling of this name are a constant source of controversy. The one which is most frequently used and officially recognized by the Bureau of Reclamation is Succor Creek. The road to Jordan Valley crossed this creek and it is related how a stagecoach was attacked by Indians and took refuge in the creek bottom. Help (or succor) reached them there and the creek was so named. A certain group vigorously supports the spelling "Suck
Creek." Whether this belief is founded on t
alleged abundance of that fish or the mine
from the East who were sold property alo
this stream seemingly cannot be agreed upo

Rough Lock Falls

Ontario.—The settlement was original
called Ione, but when the city was laid o
the name was changed to Ontario by a ma
from the Canadian Province of Ontario.

Nyssa.—There is more of the adventure a
romance of the old West linked with the sto
of the naming of the town of Nyssa. Lege
has it that a band of Mexican horsemen ran
ing far north of their usual haunts kidnap
an Indian girl named Nyssa or Nessa (na
rators disagree on the spelling). The girl
father appealed to the garrison at Fort Boi
and a soldier was dispatched to follow t
band. He succeeded in rescuing the girl, b
her freedom was short-lived because the k
napers pursued the two and killed them
they were preparing to cross the Snake Riv
where now stands the town of Nyssa. Som
stories of this episode have a "lived happi
ever after" ending, but it seems that t
tragic ending follows the facts more closely.

Some claim that the town was named f
the Nyssa tree, a species which grows in t
southern United States, while others belie
it was named by railroad men after the Gre
city of ancient history because of its brevit
a quality so desirable in railroad designatio

Johannesen Park.—By letter of January
1938, to the construction engineer, Owyh
project, the Pomona Grange stated that at
meeting on January 22 it was voted una
mously to request the Bureau of Reclamati
to designate the park as Owyhee Dam s
Johannesen Park. The grange did this as
token of appreciation of the help given by
Johannesen in the development of this area.

Construction Engineer R. J. Newell c
curred in the request in letter of February
1938 to the Commissioner of Reclamation.

In his letter of March 9, 1938 to the gran
Secretary of the Interior Ickes stated:

"The Commissioner of the Bureau of R
lamation has advised me that Allen Johan
sen, who died July 26, 1937, was employed
approximately 23 years by the Bureau
Reclamation and, for the 10 years prior
his death, was assigned to the Owyhee proj
where he was engaged principally on the c
struction and operation of the Owyhee Da

"The action taken by the Pomona Grange
requesting that his faithful and conscienti
service be recognized, by giving his name
the park at Owyhee Dam, meets with my
proval and you are hereby authorized to t
such action as seems advisable in making t
a matter of permanent record."

Belle Fourche Project, South Dakota

The Belle Fourche project is located
western South Dakota, northeast of
famous Black Hills, where the pioneer h
tory of the project area began with the d
covery of gold in 1876. Water for irriga

was first delivered to a small area on the roject in 1908. The project proper was comleted in 1911 and now has a total irrigable rea of approximately 80,000 acres. Belle ourche Dam, with its reservoir, is the key feature of the project and the largest dam in outh Dakota.

The principal names on this project originate from the city of Belle Fourche and from the river of the same name. Belle Fourche is a French name and means "beauful forks." This, in turn, has reference to he confluence of the Redwater and Belle Fourche Rivers. Frenchmen settled in this icinity in the early days and, according to eports, engaged in fur trading with the ndians as early as 1854.

Belle Fourche was located on the old S B Ranch owned by Seth Bullock, a personal riend of former President Theodore Rooseelt, who then was a ranchman of Medora, N. Dak. These men exchanged frequent visits and also engaged in numerous hunting scapades.

Marquis de Mores operated a stage line n 1884 from Medora on the Northern Pacific o the Black Hills. One of the stations on his line, named "De Mores," was located on he present town site of Belle Fourche. This was a small hamlet of four or five business buildings and a few other shacks. The stage line was short-lived, and in 1885 De Mores became a ghost town, the buildings being moved mostly to Minnesela, a small community about 4 miles southeast of the present city of Belle Fourche.

The Chicago & Northwestern Railway reached the city in 1891 and following this railway construction, Belle Fourche for the balance of the nineteenth century was considered the largest original shipping point for livestock in the United States, cattle coming from the ranges of western South Dakota, northeastern Wyoming, southeastern Montana, and southwestern North Dakota.

Newell was laid out as a Government town site in 1910, and was so named after F. H. Newell, at that time Director of the Reclamation Service. The Chicago Northwestern Railroad reached the city the same year and water for the irrigation of adjacent lands became available in 1912.

Fruitdale derives its name from the orchards of hardy fruit growing in that vicinity before the project was established. These orchards have, to a large extent, deteriorated and many have died out entirely.

Nisland was platted by the Pioneer Townsite Co., a subsidiary of the Chicago Northwestern, the land being purchased from Nis Sorenson, an old settler. It was first planned to name the place Lucerne, but this met with opposition from the Post Office Department and the name was changed to Nisland in honor of Nis Sorenson, four sons of whom are now irrigation farmers on the project, one being an irrigation district director.

Vale was settled many years before the construction of the irrigation project. In 1880 Andrew Rosander settled on the Belle Fourche River near the present town of Vale, and 3 years later applied for a post-office permit in connection with his roadhouse. The application called for the name "Valley," but this was not approved, postal authorities suggesting the name "Vale" which was adopted. The town site was platted by Mr. Rosander in 1908, but the village has not yet been incorporated.

Carlsbad Project, New Mexico

The Carlsbad project is located about 26 miles from the famous Carlsbad Cavern, believed to be the largest limestone cavern in the country, if not in the world. The project was so named because of its proximity to the mineral springs in the Pecos River about 3 miles above the town by the same name, the waters of the springs being similar in analysis to the well-known springs at Carlsbad, Austria.

The original name of the city now called Carlsbad, prior to 1899 was "Eddy," named for C. B. Eddy, the original promoter of the Pecos Irrigation Co., now the Carlsbad project.

Alamogordo Dam.—The name "Alamogordo" is a Spanish word, the literal meaning of which is "big cottonwood." Strictly speaking, the word "gordo" means "fat" but in Spanish it conveys the idea of "large" as applied to a large tree. "Alamo" means "Cottonwood." As applied to the creek by that name which enters the Alamogordo Reservoir, it is assumed the large cottonwoods growing along the banks and in the channel of the creek for some miles above its mouth were responsible for the name.

Lake McMillan was named for W. H. McMillan, a wealthy man who was associated with C. B. Eddy and was a brother of United States Senator McMillan.

Avalon Reservoir.—From an unauthoritative source it has been suggested that the name Avalon might very well be traced to the island of the same name which, according to the legends of King Arthur, was said to have been Glastonbury, near the terrestrial paradise, and the abode and burial place of King Arthur, one of the last British chieftains who struggled against the Anglo-Saxon power in the sixth century. This king defended West Britain against the Saxons and was killed in a decisive battle in the year 520.

Reclamation Construction

(*Continued from page 62*)

pressed by contractors. I refer to the type of work involved in the Great Plains water conservation and utilization program. Projects in this type of program are part relief. Some money expended is appropriated directly for this work and it is reimbursable, as is the entire cost of construction of the projects in our regular program. This money goes for supervision, for materials and supplies, and for machinery. Additional money is allotted from relief funds and is nonreimbursable. These funds are used to hire relief labor to do as much as possible of the work involved. It is a type of force account construction. It is also a desirable means of providing necessary relief later on worth-while, permanent, wealth-producing improvements. We have virtually completed one small project on this general plan. Three others are to be started in the spring. This type of project by its very nature is confined to areas where relief loads are heavy and where project costs are comparatively high when considered on a per acre basis; in other words, to such areas as the Great Plains, where droughts of critical intensities are frequent. The procedure outlined for these projects is not readily adaptable to heavy construction or large structures, because of the lack of sufficient numbers of skilled laborers on the relief rolls. I see no threat in this program to the construction industry. It is recognized that the expenditures for a given amount of work done on this plan are greater than under the contract system. This greater cost results from the limitation as to hours of work and total earnings placed by law on relief employment, from wide fluctuations in the labor supply, and from a shortage of workers skilled in the specialties of such construction. The higher unit cost, however, is amply justified, I believe, by the alternative necessity of providing less productive and desirable work at the same expense for the men on relief.

In closing, I want to repeat that by and large our relationships with the contractors have been good. The Bureau of Reclamation adheres to and approves the policy of letting its work by contract on competitive bidding. Some difficulties and bad practices have entered, but they so far have been the exception rather than the rule, and we have found nearly all contractors ready to play the game by the rules laid down in the public interest. In the few instances in which we recently have done work with Government forces, there have been good reasons for it. We will do work ourselves in the future, if there are good reasons for it, but I do not anticipate that this will often be necessary.

The volume of new work during the coming year probably will be reduced, but there will be, I anticipate, a considerable number of attractive jobs placed on the market in connection with projects now under way.

We have been engaged in a great construction program in the West, one of primary importance to the region and of benefit to the Nation as a whole. I see beyond the dams and the canals, new farms, new towns, and new homes. I see places made by completion of our present programs for a million more people, who by their labor and industry can make decent livings. It cannot be denied that such opportunities are sorely needed.

Construction of the Alamo River Crossing

By J. R. LAWRENCE, *Division Engineer*

THE years, from 1905 to 1907, witnessed the most decisive events in the long struggle between the forces of man and those of the Colorado River for possession of the fertile lands of the Imperial Valley of California. Man, with the most modern construction equipment available for the work, finally won the battle, and the closure was made of the break in the west bank of the river. Through this break, the major part of the Colorado's flow for almost 2 years had crossed Imperial Valley on its way to the Salton Sea. The power and treachery of the Colorado was well demonstrated by the manner in which it enlarged a small diversion channel that had been cut through the western bank of the river during emergency efforts to divert some of the river's low flow into the main canal. A series of unprecedented winter and spring floods later washed away embankments built across this opening before they could be completed, and the original narrow cut was enlarged to a half-mile in width, along which subsequent flood flows entered the valley.

After entering Mexico some distance south of the International Boundary, the flow proceeded in a general westerly direction to a point some 10 miles east and south of Calexico, Calif. Here a part of the flood waters turned northward into the United States and followed a shallow wash channel across the eastern section of Imperial Valley until it reached the Salton Sea; this channel was later known as the Alamo River. During the 2 years that the uncontrolled flow of the Colorado followed the Alamo Channel, the depth of the formerly narrow floodway was increased to 30 feet and had a final width of 1,300 feet. After the Colorado was brought under control and additional areas became developed, the Alamo River channel proved useful for the drainage it provided for adjacent land and for use as a wasteway to dispose of excess water from a portion of the Imperial Irrigation District's irrigation system.

At the point where it is crossed by the All-American Canal, the Alamo River usually carries 500 cubic feet of water per second during the busy irrigation season, with a maximum flow approaching 1,000 cubic feet per second during periods of heavy rain on the Mexican portion of the basin. The capacity of the All-American Canal is 4,700 secon
feet above the crossing and 4,300 secon
feet below. Facilities are provided for di
charging a maximum of 1,500 second-feet
water from the canal into the Alamo Riv
as regulation or emergency waste and f
smaller amounts to supply the irrigation r
quirements from the river.

Bedrock underlies several hundred feet
alluvial deposit in this region. Geologis
state that the bedrock is traversed by a
active branch of the great San Andreas Fau
almost directly under the river channel. F
this reason it was necessary to design
structure which could withstand earthqua
shocks to the greatest practicable exte
without material damage.

Structures

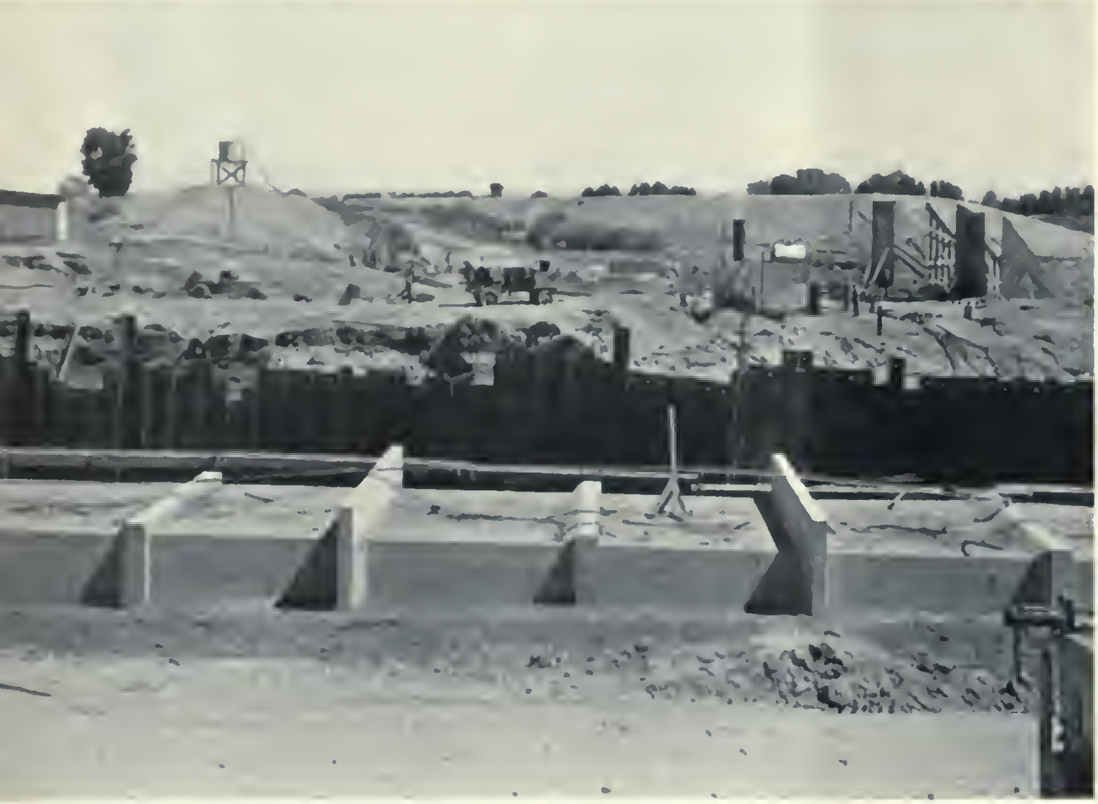
Four types of structures were consider
for the crossing, namely: a monolithic co
crete siphon under the river channel, a trip
barrelled steel pipe siphon over the river,
reinforced concrete flume on pile-support
bents, and a concrete-lined canal across t
channel on compacted fill over and arou
a concrete box culvert.

The crossing structure, as designed, co
sists of several units. An inlet transiti
leads to check and wasteway gate sectio
all founded on natural ground. Below t
check section a transition continues to t
concrete-lined canal section built on co
pacted fill, which terminates in a transiti
to the normal earth section founded on na
ral ground. This portion of the crossi
structure extends 416 feet along the can
The check structure is provided with fo
18-foot by 15-foot 3-inch radial gates equip
with electrically operated hoists.

A double 7- by 9-foot box culvert forms t
river channel through the compacted
bankment. Suitable inlet and outlet tra
tions at either end connect the culvert w
the channel banks, the outlet transition for
ing a stilling basin which retards the hi
velocity flow occurring through the culv
This structure, including transitions, exte
395.83 feet along the river channel.

The wasteway consists of a gate structu
housing two 7-foot 6-inch by 6-foot automa
float-controlled radial gates, a double box
vert section through the canal bank, a ch
a stilling pool, and an outlet transition to
right bank of the river channel. The nu
matic gates will serve to maintain a pre
termined maximum water surface in the ca
or may be fully opened to waste 1,500 seco
feet. The drop in water surface betw
normal canal and river water surfaces is ab

The river culvert, completed and partially backfilled. The river has been diverted on the opposite side of the steel piling. Completed section of the canal in background



24 feet. The length of the wasteway structure is 188.69 feet.

Due to the fact that the available compaction material was a fine silt, with low stability when saturated, it was deemed necessary to prevent water from the canal from seeping into the embankment. An 8- to 9-inch concrete lining was provided for the canal section in the compacted embankment. The lining overlays a blanket of screened gravel, 6 to 12 inches in thickness, which will serve to drain any water penetrating the lining membrane. The gravel blanket is in turn drained by 3 lines of 6-inch sewer tile, laid with open joints which discharge through the culvert top. The gravel blanket was placed on the embankment slopes and floor, screeded to subgrade shape, and its surface stabilized by the application of a thin coat of gunite.

The outer slopes of the compacted fill are weighted and drained by a layer of pit-run gravel, extending from the top of the bank to 9 feet below the culvert transition grades. This blanket varies in horizontal thickness from 3 feet at the top of bank to 21 feet at the elevation of the transition floor. Sewer tile underdrains are provided under the culvert outlet transition floor, so as to balance external and uplift pressures.

All portions of the structure are jointed, so as to provide articulated units free to move with either settlement or earthquake shocks. Transverse joints were provided across the concrete-lined section at intervals of 23 feet 6 inches, and longitudinal joints were provided at the base of each slope slab. All joints are sealed against water leakage by means of specially molded rubber diaphragms which span the joints and are embedded in the concrete on either side thereof. Elastic fillers of sponge rubber and dehydrated cork are provided in the joint between the adjoining concrete, so as to further reduce the restraint between adjacent units that may be subjected to displacements.

Contract Awarded

A contract was awarded during June 1938, for building the structure. The main canal had been previously excavated up to each bank of the channel. The method of constructing the crossing consisted of first bypassing the river around the site, then installing the culvert complete with inlet and outlet transitions, diverting the river through the culvert, and backfilling the culvert and river bed. The uncompleted section of All-American Canal was then built across the fill with construction comprising compacted embankments and a concrete lined water-carrying section.

The contractor's first construction problem dealt with diversion of the Alamo River to permit the construction of the culvert. A cofferdam was constructed by driving a continuous double row of steel sheet-piling along the channel. By the use of wing walls (see fig. No. 2), the stream was diverted along one

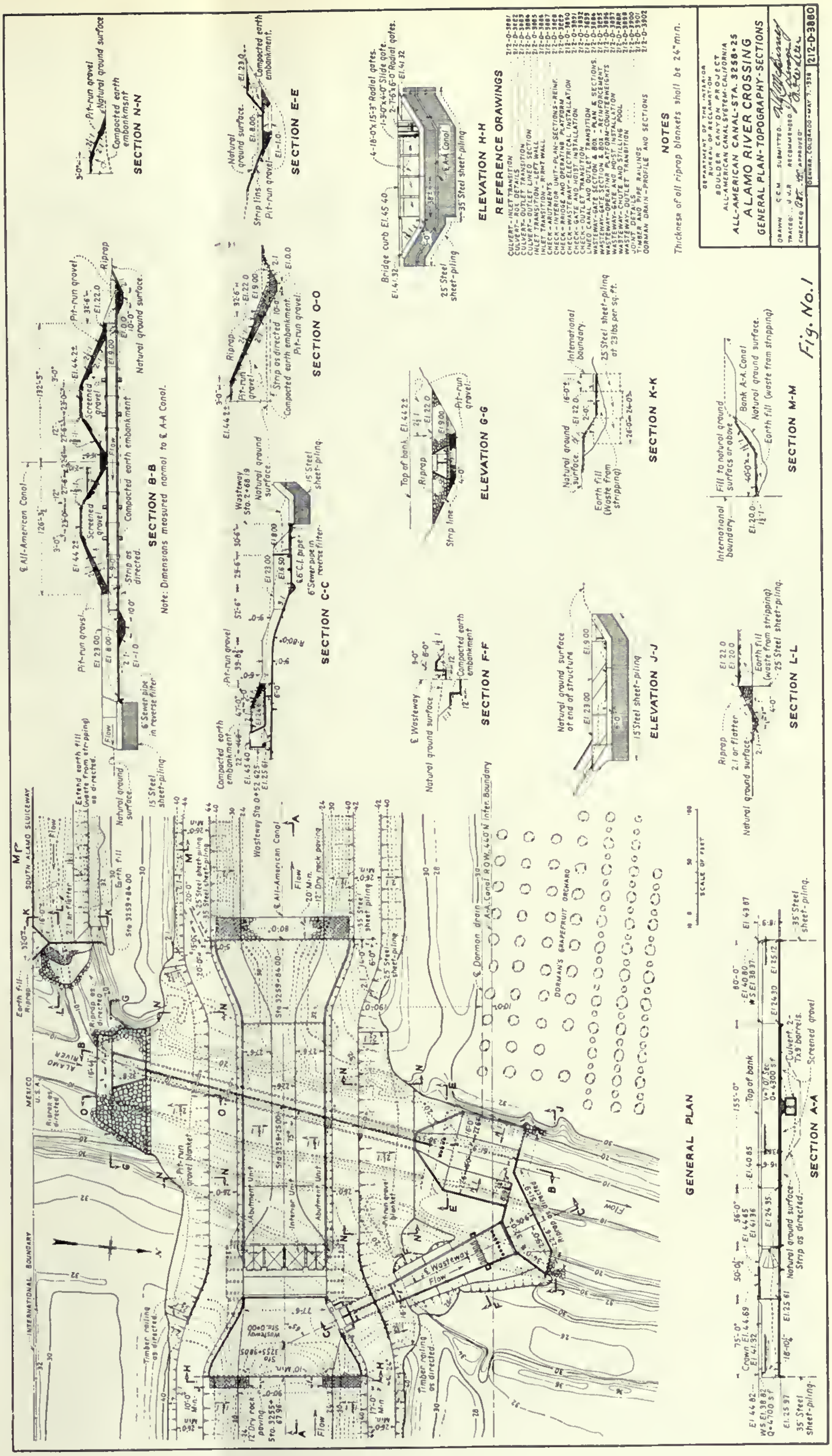


Fig. No. 1

Placing gunite to stabilize the gravel blankets on the completed compacted banks of the All-American Canal across the Alamo River

side of the piling, while excavation and unwatering was completed on the other side. To provide a firm foundation for the culvert, a 5-foot overburden of silt was stripped from the river bed. This was removed not only from the area immediately underlying the culvert, but from the entire area upon which the compacted canal banks were to rest. The difference in elevation between the completed excavation and the water surface in the diverted river was 11 feet. Overturning moments on the sheet piling were compensated by the installation of an extensive system of steel cable ties to the bank.

Upon completion of the concrete culvert and the placing of compacted backfill over the barrels, the river was diverted through the culvert and the temporary steel sheet-piling removed. The next stage was the compaction of the canal embankments across the top of the fill. It was desirable that the compacted banks should reach a final settlement status before the concrete lining was placed. In order to determine the amount and rate of settlement of the banks, a group of four settlement-recording wells was installed in the canal banks, with sections being added as the embankment increased in height. The wells were arranged so that one well was located on each side of the culvert in both the right and left banks of the canal. The wells were located over those areas of the riverbed that were stripped to the lowest elevations, and extend from the top of the compacted embankment to a depth of 3 feet below the foundation stripping. Each well consists of alternate sections of 1½- and 2-inch pipe fitted so that a short length of the smaller pipe telescopes inside the larger, permitting vertical movement of the pipe sections at the various elevations in the embankment. Frequent observations of the offsets between the two pipes were made.

As an indication of the state of compaction obtained in the initial work, a period of 2 weeks after placement showed a maximum drop of only six one-hundredths of a foot. In a 3-month period following that, no settlement has been noted.

The Alamo River crossing was completed in December 1939. This event marks the completion of the final All-American Canal structure, and symbolizes the beginning of a new era for the Imperial Valley of California. From its headworks, some 15 miles east of Yuma, Ariz., the All-American Canal runs for a distance of 80 miles, to the western boundary of the Imperial Valley. In addition to serving the farms and cities of Imperial Valley, the canal will supply Coachella Valley through a branch canal now under construction. Provision has also been made at the western terminus of the All-American Canal for the city of San Diego to receive 155 cubic feet of water per second, the right to which will not be demanded until that city's present supply is required to be augmented.

Reclamation Engineers Receive New Assignments

C. C. FISHER, construction engineer of th Deschutes project, with headquarters at Bend Oreg., has been placed in charge of preliminary investigations on a proposed Reclamation project in the Willamette Valley, Oreg., and Dean S. Stuver, for the past 3 years Assistant General Supervisor of Operation and Maintenanc for the Bureau of Reclamation, with headquarters in Washington, D. C., has been appointed to succeed Mr. Fisher.

C. C. Fisher has been with the Bureau o Reclamation since 1903, as engineering aid assistant engineer, and full engineer, respectively. In 1919 he was placed in charge o secondary investigations on the Owyhee, Judith Basin, San Carlos, Boulder Canyon, Deschutes, Baker, San Juan, and Chico project In 1929 he was in charge of investigations o the Upper Gila River; from 1934 to 1937, th Deschutes Basin; and in 1937, the Grand Ronde. He has been construction engineer o the Deschutes project, on which first contract were awarded last July, since its inception.

Deane S. Stuver was first employed by th Bureau in 1910, on the Newlands project Nevada. He was successively promoted fro junior to assistant to associate engineer, an in 1926, he became project manager. In 193 he was assigned to Washington, D. C., fro which post he received his present assignmen

Both Mr. Fisher and Mr. Stuver have ha long and varied experience with the work o the Bureau since its earlier days, and are we fitted for their new assignments. Mr. Stuve is especially qualified for the duties on th Deschutes project, which has three CC camps; he was in charge of the CCC branc of the Bureau's work from its inception unt August 1936, when he became connected wit the Operation and Maintenance Division of th Bureau.

Orland Activities

THE Orland project has inaugurated a serie of five weekly public forums, to be held by th Orland Night School, the first of which o curred on January 18. These public forum open to the general public, are based on "International Relations" and feature outstanding speakers from the faculties of nearb colleges.

Interior Officials in West

UNDER Secretary of the Interior A. L. Wirt and Mrs. Wirtz, accompanied by Assistan Commissioner of Reclamation H. W. Bashor and Joel D. Wolfsohn, executive secretary o the National Power Policy Committee, mad a brief tour of some of the western reclama tion projects during the month of Marc Their trip included Grand Coulee, Yakima and Boulder.

Salt River Directors Inspect New Power Line

OF special interest and vital importance to the Salt River Valley is the 140-mile high-tension transmission power line recently completed by the Bureau of Reclamation from Parker Dam on the Colorado River to Phoenix, Ariz., connecting at a substation at Parker Dam with another power line running up to Boulder more than 150 miles distant. Every person living on the Salt River project is affected directly or indirectly by this line.

Throughout the construction period, from the day the first survey stake was set until the switch was closed to bring electric power from Boulder Dam to Phoenix, it has been news. Among other items of publicity which have kept the job in the public mind was a full-page illustrated story in the Arizona Republic of December 18 last. Also, at a later date, in January, a window display devoted to the transmission line in one of the large show windows of the Arizona Republic attracted wide attention.

Doubly interested in the early completion of the line is the Salt River Valley Water Users' Association because they are to receive the first block of power delivered over it. Power has been sorely needed because low water in the Salt River reservoirs has seriously curtailed the output of the association's hydroelectric plants. The new line will supply the needed power not only to Phoenix homes, but to other towns and irrigated farms in central Arizona, where extended drought and small stream run-offs from the mountains had cut down the amount of hydroelectric energy available.

Power for the region is ordinarily supplied by the Salt River Valley Water User's Association, which is the organization operating the Salt River Valley project, and the Central Arizona Light & Power Co., a private utility.

Present Power Contract

The power generated at Boulder and now delivered via Parker Dam over the new line is power allotted to the Metropolitan Water District of Southern California, an incorporated union of 13 cities including Los Angeles, but unused by it owing to the fact that its Colorado River aqueduct pumping requirements at present leave a surplus available. The Salt River Valley Association has contracted to buy power from this surplus until a power plant now under construction at Parker Dam is completed.

After Parker's power plant is completed power will be delivered directly from Parker Dam instead of from Boulder, to the Phoenix area. Both the Salt River Valley Association and the Central Arizona Light & Power Co. have already entered into 20-year contracts with the Government to buy Parker-generated power when it is available for delivery.

The Boulder power now being delivered to the Salt River Association over the new line costs 1.63 mills per kilowatt-hour, the firm energy rate for Boulder power, plus a generating charge of 28 cents per month per kilowatt of maximum demand.

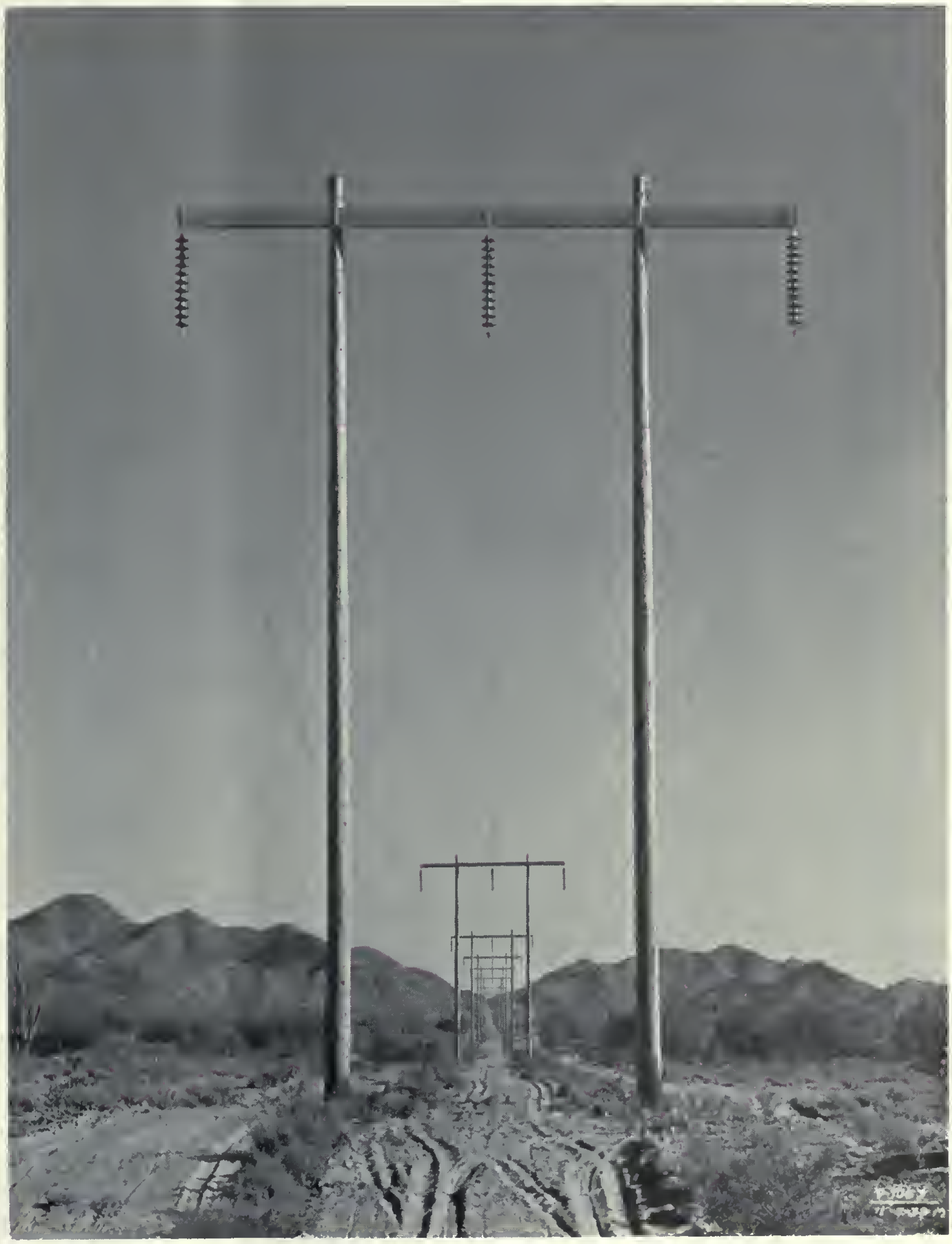
Parker Dam power, after completion of the plant, will sell for 1.9 mills per kilowatt-hour plus $6,250 per month for a generating charge. However, the Central Arizona Light & Power Co. and the Salt River Association have each guaranteed a minimum annual payment for the power of $220,000 a year. Each is entitled to take up to the maximum rate of delivery of 30,000 kilovolt-amperes, under their 20-year contracts.

The new line is a three-phase, single-circuit, 60-cycle, H-frame line carrying 161,000 volts. It cost about $1,500,000, which will be repaid to the Government out of power revenues.

The association's active interest and helpful cooperation has been evidenced in many ways. On two occasions a group of their directors made an inspection trip over the line to see for

(*Continued on page 71*)

140-mile high-tension power line from Parker Dam to Phoenix



Closure Gates

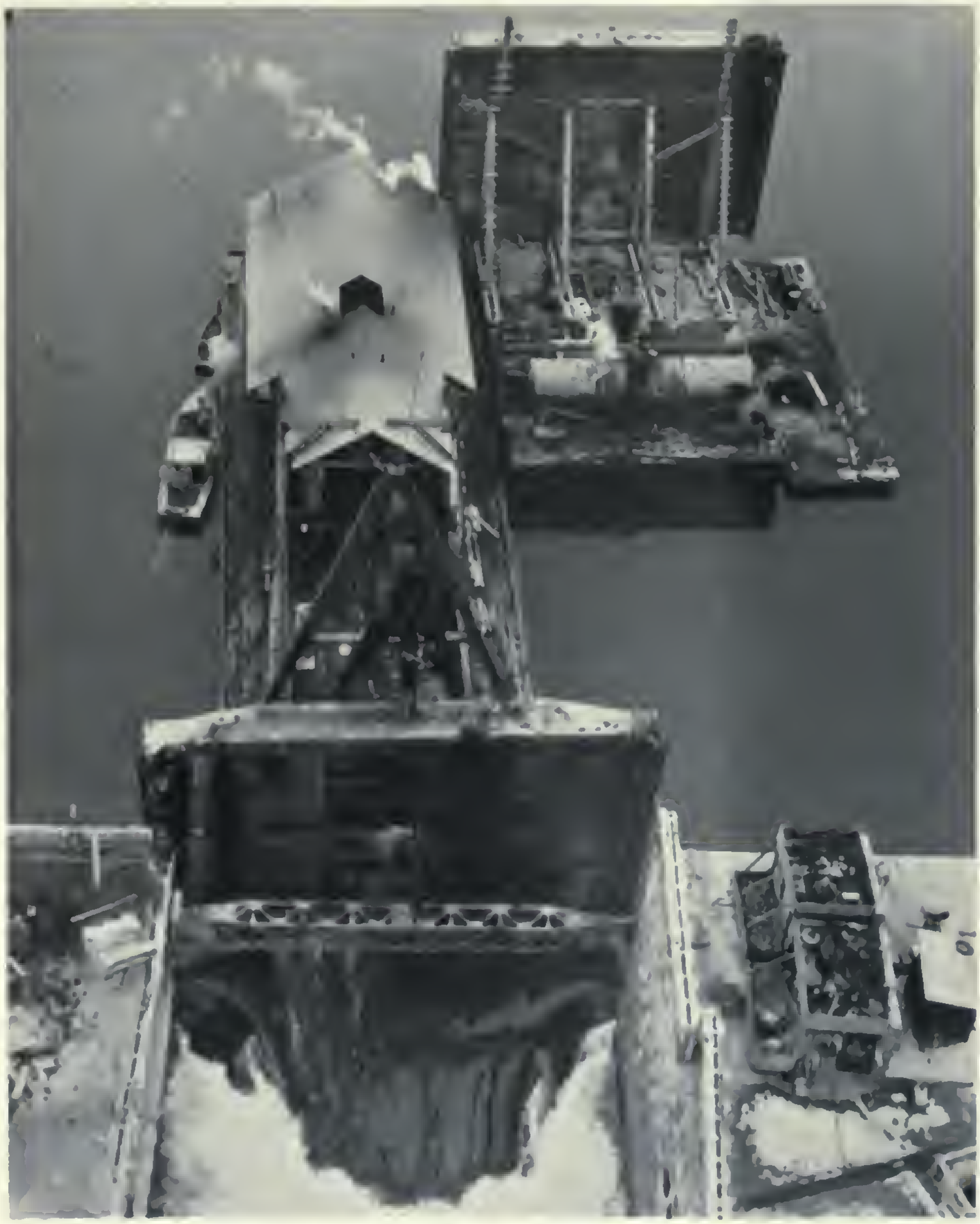
Columbia Basin Project, Washington

STEEL gates of unusual size and of ingenious design are used in diverting the Columbia from one to another group of low gaps in the Grand Coulee Dam while the spillway section is under construction.

The base of the dam was completed across the canyon of the Columbia River late in 1937, and since that time the water of the river has flowed through many low gaps in the spillway section of the structure.

As the spillway section is built up, several of the gaps are closed at their upstream ends by large steel gates resting against and making watertight joints with adjacent high blocks 50 feet apart, while the river flow passes through the gaps remaining open. The bottoms of the open gaps are above the downstream water level, so closure gates are required at only the entrance to the gaps. A considerable head has developed at these points.

This gate, more than 50 feet wide and weighing 75 tons, is handled by a large barge and is used to divert the flow of the Columbia



Two kinds of devices are used in closing the gaps, the steel gates themselves and so-called gate frames which make connections between the concrete and the gates. Eight gates and nine gate frames have been built. The gate frames are installed first, the extra frame making it possible to transfer a gate from one gap to another without waiting for a frame to be transferred.

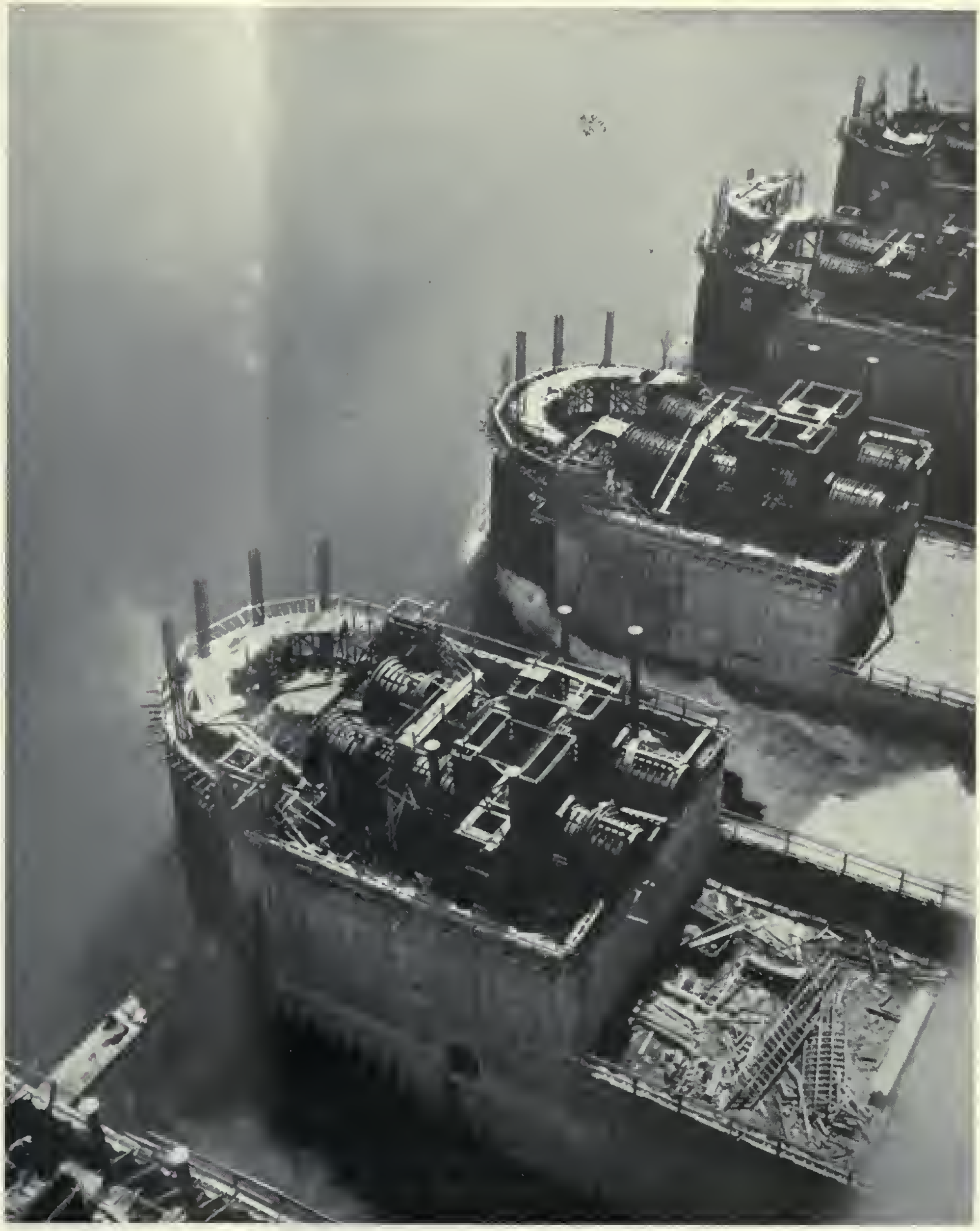
Each gate is 35 feet high and a little over 52 feet wide. It consists of 9 horizontal plate girders about 3 feet deep at the ends and 5 feet deep about 15 feet each way from the middle. Side girders and a steel plate cover on the flat, downstream face complete the main structure. Along each vertical edge, on the downstream face of each gate, is a row of 20 steel rollers 16 inches in diameter and with faces 5⅞ inches wide. They run on steel roller guides on the gate frames and make it possible to slide the gate while it is under hydraulic pressure.

Parts of the gates were fabricated in the shops of the Pacific Car & Foundry Co. at Seattle, and assembled on the base of the dam. Each weighs 70 tons. In the lower part of each gate is a closed chamber about 5 feet high. Valves are provided for filling and draining the chamber, and for admitting water through the gate to equalize pressure on the faces of the gate when it is to be removed from a closed channel.

The gate frame is a device designed to admit of making a watertight connection to the concrete on each side and at the bottom of an open gap, without being hampered seriously by the swift current entering the gap. It consists of two heavy H-column steel shapes for the vertical members, a box girder connecting their lower ends, and a removable lattice truss connecting their tops. A dressed timber filler on one flange of the H-shape makes contact with the concrete; and a projecting piece of ⅝-inch belting, clamped between the wood and the steel, is forced by the water back of the gate into watertight contact with the concrete.

The gate frame is suspended by brackets attached to its vertical members and hooked over anchor bolts set vertically in the corners of the concrete blocks bounding the low gap. The weight of the frame, and the force of the current entering the gap keep the frame in place without additional fastenings.

After a gate frame is in place, closure is completed by setting a gate in the frame. This is accomplished by means of a "hoist-barge" with an A frame at one end. It takes a gate from a transfer barge; drifts into position in front of an open gap, under control of heavy cables anchored upstream; enters the vertical rows of rollers at the edges of the



Placing four pairs of outlet works gates and conduit at the 1,036-foot elevation of the spillway section of the dam

gate into the roller guides formed on the outer flanges of the H-shapes by the addition of welded flanges parallel to the web; and lowers the gate upon the boxsill at the bottom of the gate frame.

Watertight connections between the gate and the frame are made by a rubber gasket between machined surfaces on the bottom of the gate and the top of the frame sill, and by ⅜-inch belt attached to the outer vertical edges of the gate and forced into contact with the gate frame by the water. The entrance being closed, the gap drains downstream, and the surfaces are cleaned to make good joints with fresh concrete.

With a gate in position and secured to the gate frame, the lattice truss joining the tops of the vertical members of the gate frame is removed to make room for concrete forms for the upstream face of the dam. Seepage water is pumped out of the sump formed by the gate and frame below the entrance to the gap.

A gate is removed by the hoist barge after concrete is placed in the gap it has closed by admitting water behind the gate to equalize the pressure on the faces of the gate. Required hoisting capacity is reduced by filling the chamber in the gate with air.

The gates were designed by and are the property of the Consolidated Builders, Inc., contractors for the completion of the dam.

Public Land Opening

ON THE Sun River slope division, Sun River project, Montana, public land opening is announced for April 22 of 141 farm units ranging in size from 30.8 to 157.4 irrigable acres. Literature on the subject is available on application to the Commissioner, Bureau of Reclamation, Department of the Interior, Washington, D. C.; or the Superintendent, Sun River project, Fairfield, Mont.

Salt River Power

(*Continued from page 69*)

themselves what was being done. The first trip was made early in the summer after the line was located and before actual construction was begun. The second trip took place on January 17 and 18 when a party of association directors under the leadership of Lin B. Orme, president, and Harry J. Lawson, chief engineer, went over the job to see the line ready for use, except for one short section which was rapidly being completed. Directors making the trip were R. K. Wood, James Thomas, I. E. Moore, John H. Dobson, J. A. Sinnot, T. J. Hughes, and E. F. Sargent. The party left Phoenix early on the morning of January 17 and spent all day driving over the line to Parker Dam where the night was spent in the Government camp. The next morning, before returning to Phoenix, the party was shown Parker Dam and the site of the power plant where active construction is getting well started. Also of great interest to everyone were the pumping plants of the Metropolitan Water District of Southern California which were inspected throughout. Upon their return to Phoenix, the members of the party were unanimous in their approval of what they had seen.

Klamath Community Organization

THE association of dairymen and distributors, recently organized on the Klamath project, held its first annual dinner during December. The dinner was attended by 175 members and interested patrons. The organization works in cooperation with the Oregon Dairy Council, public health units, and public schools.

Orland Grows First Crop of Broccoli

HARVESTING of a 5-acre tract of broccoli was started on the Orland project during January. As this is the first commercial planting of broccoli in the history of the project, it is being watched with much interest. The product is of excellent quality and is yielding 5,000 pounds per acre. The entire crop is being sold in local markets.

The Snow Lake Tunnel

Migratory Fish Control, Columbia Basin Project

By CARL J. NIELSEN, *Associate Engineer*

A 2,500-FOOT rock tunnel, tapping a mountain lake 150 feet below its surface, in order to supply cold water for a fish hatchery at Leavenworth, Wash., was driven in 1939 by the Bureau of Reclamation, as a part of the migratory fish control program of the Columbia Basin reclamation project.

The Grand Coulee Dam is so high that neither ladders for the accommodation of fish bound upstream to spawn nor means of passing fingerlings safely downstream over the dam are practicable. As a consequence, future generations of that relatively small fraction of the Columbia River migratory fish run which used the river above the dam must hereafter be cared for below the dam. This will be done by transplanting them into tributaries which enter the Columbia below the Grand Coulee Dam, and above the Rock Island Dam, where the adult fish can be trapped on their way upstream.

Valve for tunnel control works at Snow Lake, awaiting transportation over 6-mile trail to the lake

The fish will be transported in specially designed refrigerated and air-conditioned tank trucks to a hatchery under construction by the Bureau at Leavenworth; and fry or fingerlings will be planted in the Wenatchee, Entiat, Methow, and Okanogan Rivers, to which they will return to spawn naturally after maturing at sea. Providing a water supply sufficient in quantity and suitable in temperature for the proper operation of holding ponds, hatchery, and rearing ponds presented many engineering problems.

Water for the main hatchery at Leavenworth is obtained from two sources: Icicle Creek on which the holding ponds and hatchery are located, and the Wenatchee River from which a supplementary supply is furnished through a diversion canal of 160 cubic feet per second capacity. The hatchery and holding pond operations will require water of relatively low temperatures to maintain the vitality of the adult fish and produce the best spawn. In their upstream migration after leaving the salt water of the sea, the fish are often bruised and otherwise injured in the course of their travels to the spawning areas. These injured areas are subjected to attack by fungus and vermin detrimental to the fish, and many die as a result. The higher the temperature of the water the greater the rapidity with which these attacks take place. For this reason an adequate supply of cool water is essential for the successful operation of the hatchery.

Water from Icicle Creek is of desired low temperatures throughout the year; but during the late summer months, the water in the Wenatchee River increases in temperature so that the use of this water alone is not considered advisable at such periods of the year. To offset the objectionable high temperatures of the Wenatchee River water, it is proposed to mix or temper it with the cooler supply from Icicle Creek to produce a blended supply conducive to good hatchery growth and care, and of required temperatures. This proposed plan of maintaining a satisfactory water supply for the hatchery was further complicated by the fact that during the latter part of each summer the flow in Icicle Creek is rapidly diminished owing to irrigation diversions above the hatchery area and to the natural decrease in run-off. The flow is reduced to such an extent that sufficient water is not available to temper the Wenatchee River water properly for the hatchery and holding-pond operations. This decrease in the natural cold-water supply which might seriously disrupt operations and defeat the purposes of the hatchery, necessitated the development of an additional cold-water supply of sufficient volume to insure the successful operation of the hatchery throughout the critical summer months.

Investigations indicated that a supplementary storage supply of cold water could be made available from an isolated and undeveloped region on the headwaters of Snow Creek, a tributary of Icicle Creek, about 7 miles from the hatchery station and at an elevation nearly 1 mile above it. Located at this point are two lakes which drain an area of approximately 4.7 square miles between 6,000 and 8,700 feet in elevation. This area is subjected to heavy snowfall and in the higher elevations is ice-capped or glacial in character. The lower lake is small and shallow, but the upper lake covers an area of 111 acres and is very deep.

At the outlet from the lower lake a good site was discovered for the construction of a small dam to create the desired storage. However, the scarcity of earth and loose rock in this area for construction materials, and the inaccessibility of the site for transportation from outside sources discouraged the construction of such a dam.

The Upper Snow Lake is separated by a narrow granite ridge from another small lake (Nada Lake) located about 470 feet below, and to the north. The outlet from Nada Lake also discharges into Snow Creek. Study revealed that by driving a tunnel through the ridge separating the two lakes, to enter the bed of Upper Snow Lake, about 150 feet below the water surface, it would be possible to develop approximately 12,000 acre-feet of natural storage, because of the unusual depth of the lake.

Before work could be undertaken on the construction of the tunnel it was necessary to prepare a means of access to the lake for the transportation of equipment and supplies required in the tunneling operations. Contract was entered into with the United States Forest Service for the construction of a trail 30 inches wide from Icicle Creek to the site of the proposed camp at Nada Lake, a distance of approximately 6 miles. Work on the trail was commenced September 12, 1938, and the trail was sufficiently opened on October 17, 1938, to permit the first movement of materials and supplies to the Nada Lake camp, although the trail could not be used to good advantage until November 3, 1938.

Materials Moved by Pack Trains

Transportation of the necessary supplies and equipment from Icicle Creek to the base of operations at Nada Lake camp was an item of major importance. Bids were opened for two alternative methods of transportation—airplane and pack train. Contract was awarded to the low bidder for pack trains, the successful bid being considerably below the bid for transportation by air. Movement of materials to the camp site was commenced during the latter part of October to permit the construction of a permanent camp headquarters and make possible the commencement of excavation on the tunnel during the winter months so that the storage supply would be available for hatchery operations at the earliest practicable date.

The driving of the tunnel was undertaken with Government forces to expedite the start of operations and eliminate the delay required to advertise and award work under a separate contract. A camp established at Nada Lake consisted of dormitories, mess hall, cook shack, compressor house, blacksmith shop, powder shed, and other facilities to accommodate the forces required for the tunneling operations and to serve as a base for construction activities. Daily contact was established with the Leavenworth office by means of short wave radio, operated at regular prescribed intervals.

Actual excavation at the tunnel portal was commenced late in November 1938. The tunneling operations were conducted on a 3-shift-per-day basis with crews of miners, laborers, mechanics, blacksmiths, carpenters, and other personnel required to maintain continuous operations in the tunnel. The tunnel was excavated 5 feet in width and 7 feet in height, the smallest section to which the tunnel could be advantageously and economically worked. The general plan of tunnel advancement was to excavate the heading to the full tunnel section, drilling an average of 23 holes in the heading for each round to a depth of approximately 5 feet. An average of 100 pounds of 40 and 60 percent gelatine dynamite was loaded in the holes for each round, and the average tunnel advancement per round was 4.2 feet, involving approximately 6 cubic yards of material. Five electric delays were ordinarily used in shooting the rounds, and the electric current was supplied from a 110-volt, direct current power and lighting circuit. Compressed air for operation of the tunneling equipment was furnished by two compressors of 210 and 315 cubic feet per minute capacity.

The tunnel was started at an elevation

Conveying a heavy valve over a rocky trail in the Cascade Mountains for the control of the flow of cold water from a high mountain lake to an enormous fish hatchery under construction at Leavenworth, Wash.

Horses are used to carry, high up in the Cascades, equipment to control the icy flow from the bottom of Snow Lake through a 2,500-foot tunnel to the fish hatcheries

about 200 feet below the surface of Snow Lake (station 0+13), and carried upward toward the lake on a slope of 1 foot per 100 feet for a distance of approximately 2,500 feet. The rock encountered was a hard and dense granite of excellent quality so that it was unnecessary to timber any part of the tunnel. A few seams were encountered in the rock for the first 40 feet of excavation, but in the next 1,000-foot section the rock was almost entirely free of seams. A fault or split about 1 foot in thickness and completely filled with vein or dyke material was encountered crossing the tunnel diagonally at station 10+60, but the fault was tight and carried no water. Between stations 15+80 and 16+60 a number of open water-filled seams were crossed which drained readily, indicating no connection with the lake located about 250 feet above and to the left of this area. At station 16+85 a second vein about 2 feet in thickness was encountered but developed no difficulty due to water or unsatisfactory rock. At station 21+80 the tunnel passed under the edge of the lake about 170 feet above and continued through hard dry rock to station 25+15 where the horizontal reach was terminated.

As the tunnel heading approached the lake, "feeler" holes were drilled upward and ahead of the heading, to determine that a sufficient thickness of rock was located above and in advance of the heading to permit the continuation of the excavation. It was intended to drive an inclined heading perpendicular to the lake bottom from the end of the horizontal tunnel near station 25+15, but the "feeler" holes indicated the presence of a loose boulder liable to obstruct the tunnel opening after the last blast, so a new approach was made by driving a new heading diagonally upward from a point about 16 feet back from the end of the original adit, to avoid the boulder and also water-bearing fissures penetrated by other test holes. Drill holes from the new heading indicated some broken rock and seams immediately adjacent to the lake bed, but revealed that the bed of the lake in the location of the proposed tunnel entrance was entirely free from loose or slide rock, but was covered by a layer of fine silt mud. This condition was previously indicated by soundings made through the ice to determine the character of the lake bed and to ascertain a satisfactory location for the tunnel entrance into the lake. As a result of these soundings the lake bed was found to be smooth with a slope of 1:1.7 at the site of the proposed entrance. The thickness of the mud layer was found to vary from 2 feet to 3½ feet at the particular area in question.

With its location thus established, the entrance into the lake was prepared by excavating an inclined tunnel section upward from the main bore on an angle of 57°30' with the horizontal, starting in the tunnel proper between stations 24+89.8 and 24+95.7. Excavation of the inclined tunnel followed the same procedure used in the main part of the tunnel, and was carried to a point 7 feet from the lake bed. This section of the tunnel converged as it approached the lake to lessen the possibility of a large piece of broken rock or a boulder lodging or wedging in the main entrance section when the final shot was fired. The last 7-foot section was drilled to receive the final charge, and work was then discontinued on the heading until other features of the tunnel were completed.

Catch basins or sumps were excavated in the floor of the tunnel to collect the debris and rock resulting from the final blast. The first sump was located at the foot of the inclined tunnel, and four additional sumps were provided at varying intervals along the main bore to receive the rock which might be carried beyond the first sump. As each sump was completed, all tunneling equipment was removed, and final clean-up of the sections completed.

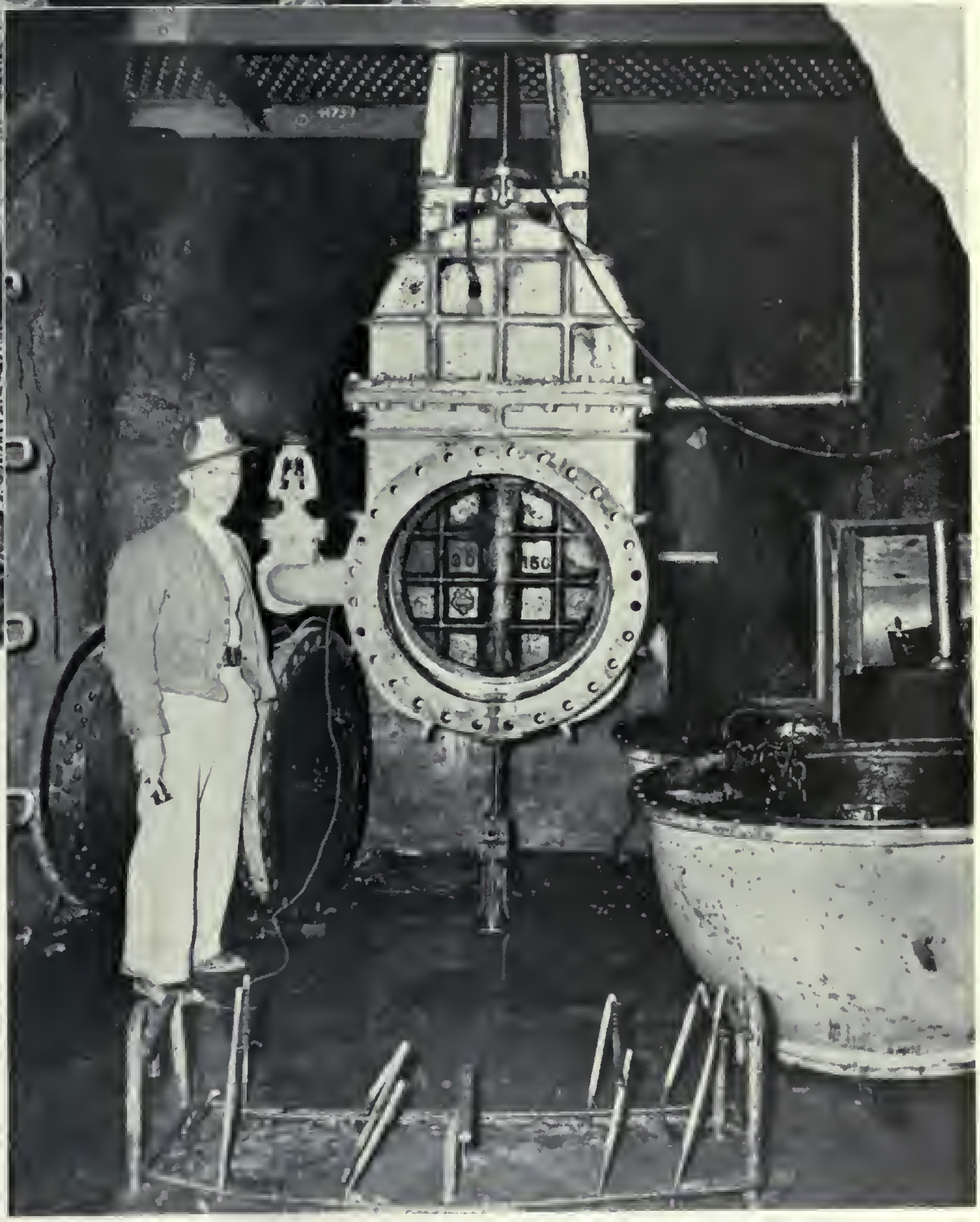
The excellent quality of the rock in which the tunnel was excavated permitted the tunnel to be placed under pressure without lining or other protective treatment. It was desired to locate the outlet works as near the portal as possible to eliminate the requirement for an auxiliary or entrance adit to reach the operating valves. However, to reduce the chance of leakage from the tunnel, due to joints or openings in the rock

Lower portal, Snow Lake main tunnel, tapping upper Snow Lake, and adit tunnel to control gate chamber

near the portal, it was decided to construct the outlet works about 150 feet from the portal, in the center of an unusually massive and monolithic zone of granite which would require a minimum amount of grouting to effect a tight seal. This necessitated the excavation of an adit which was located 10 feet above, 15½ feet to the side of, and parallel to the main tunnel. A valve chamber or operating room 10½ feet wide, 11 feet long, and 9 feet in height above the tunnel was excavated at the valve location.

The outlet works consist of a concrete bulkhead 7 feet 4 inches in thickness keyed into the granite at station 1+64 and grouted in place; a 30-inch diameter plate steel pipe assembly 27 feet 8 inches in length, with bell mouth entrance from the inside of the bulkhead; and two valves at the end of the pipe, a 30-inch, cast-steel gate valve for emergency purposes and a 28¼-inch diameter tube valve to regulate the discharge. Two reinforced concrete piers are provided to support the pipe and valves downstream from the bulkhead. The valve controls are located on a platform grating in the valve chamber directly above the valves. A 2-inch diameter pipe line is carried through the bulkhead and connected to a pressure gage located in the valve chamber to record the pressures within the tunnel upstream from the bulkhead. Aggregates for required concrete construction in the outlet works were screened from tunnel muck. Mixing was per-

Control valve in place, Snow Lake tunnel



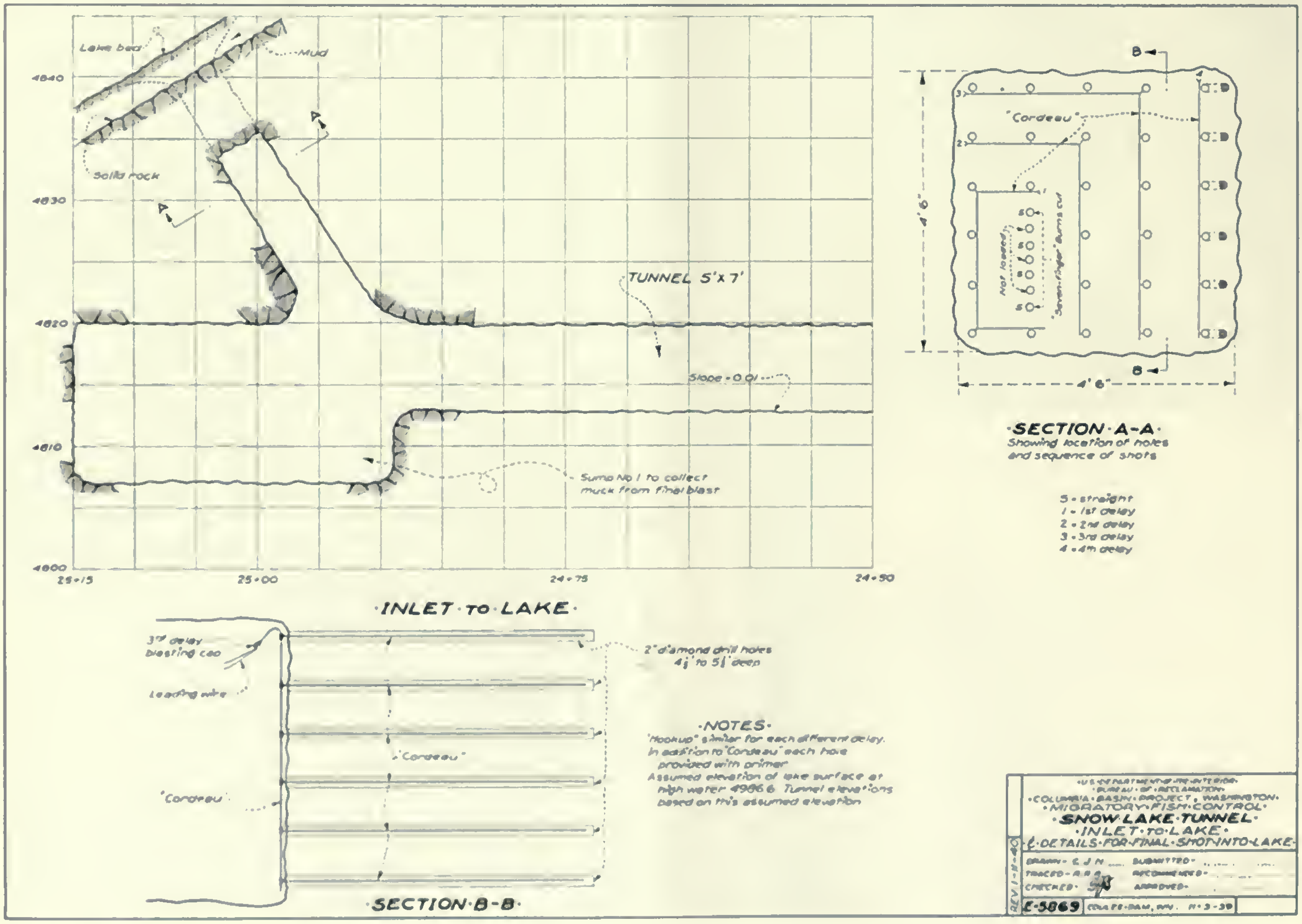
formed with a 3½ cubic foot batch mixer, and concrete was placed by hand.

Following the installation of the outlet pipe and the 30-inch gate valve, preparations were made on October 14, 1939, for the firing of the last shot to remove the remaining 7 feet of rock at the tunnel entrance to the lake. The absence of loose rock overburden at the site of the tunnel opening permitted the use of a relatively small quantity of powder for the final blast since it was unnecessary to add an additional charge to throw such overburden materials out into the lake away from the tunnel entrance. A total of 32 holes in the heading was loaded with 220 pounds of 60-percent gelatine dynamite, it being desired to break the rock into small fragments to prevent the possibility of large pieces lodging or wedging in the opening. Ventless electric blasting caps of "no delay," and four different delays were used in firing different charges of the last round. Since the loaded holes would necessarily be exposed for some time to possible moisture in the tunnel before the round could be fired, it was considered advisable to provide auxiliary circuits to insure the firing of all holes in the event of the failure of any electric detonator. For this purpose a separate circuit of "Cordeau" interconnected all holes of the same delay period and each such "Cordeau" circuit was connected to an independent firing circuit through a delay cap of the same period. The leading wires for both circuits were carried to the valve chamber, where the firing switch was located, by passing the wires through the 2-inch diameter pressure gage pipe in the concrete bulkhead. The pipe was provided on the outside end with a gate valve for closure after the shot was fired and the wires had served their purpose and were severed.

When the holes were loaded and connected, timbers, ladders, and other materials were removed from the tunnel, and the 30-inch gate valve was closed to seal the tunnel, in preparation for the blast. The switch was thrown in, and a period of several seconds elapsed before any sound was heard at the gate chamber and the rush of air noted through the 2-inch pressure gage pipe. The ignition wires having been cut off, the valve on the 2-inch line was then closed, and the gage registered a maximum pressure of 86 pounds per square inch approximately 1 minute after the shot was fired. This pressure was maintained for a short period of time, after which the pressure dropped to 75 pounds per square inch, and then increased again to 80 pounds per square inch where it remained constant. It is estimated that between 2 and 3 minutes were required to fill the tunnel after the shot was fired. A very slight leak was noted at the top of the concrete bulkhead, but the valve and connecting pipe showed no sign of leakage.

As nearly as could be ascertained, only one explosion took place when the firing switch was thrown in. If only one explosion did occur, it is possible that the shock from the first charge ignited detonated other charges.

Since the regulating tube valve could not be installed until the operations in the tunnel were completed, only a very rough estimate of the rate of flow into the tunnel could be made. The installation of the tube valve was completed and the valve first opened on October 26, 1939, and tested to one-half opening. The amount of water discharged indicated that the opening into the lake was of sufficient size to serve the purposes of the tunnel. Final testing on the valve will be completed to full opening as soon as work now in progress on the holding ponds at the Leavenworth hatchery station is completed.



Clearing Kachess Reservoir Area with C.C.C. Forces

Yakima Project, Washington

By PAUL TAYLOR, *Assistant Engineer*

KACHESS RESERVOIR is the second largest of six reservoirs which supply stored water for the Yakima project. The dam forming this reservoir was completed in 1912. It was built across the Kachess River a short distance below a natural lake, of glacial origin, where it raised the natural lake surface approximately 40 feet. In the natural state, this lake consisted of two parts—a big lake, the upper end of which was connected with a little lake by a channel, called the "narrows." At high stages one lake is formed, which is about 10 miles long and 1 mile wide, with a shore line of about 23 miles.

The area flooded by the construction of the dam was covered with timber, a large portion of which was merchantable. Several unsuccessful attempts were made to sell this timber by contract. Part of the timber was harvested by construction forces before it was killed by filling the reservoir. After a few years the area of flooded timber formed a mass of debris, portions of which floated about the lake and became a menace to the spillway and outlet works.

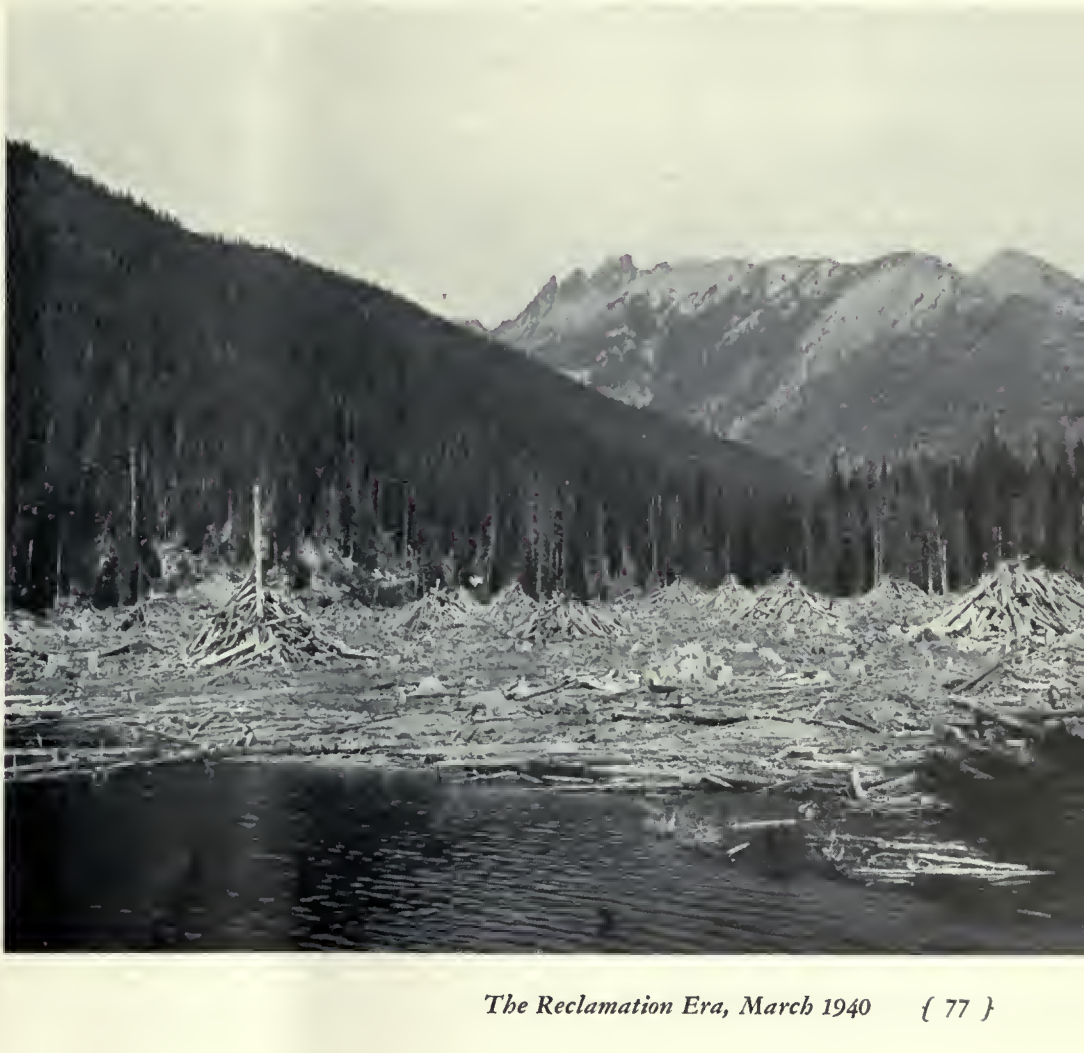
By 1930 it was evident that this menace must be removed. Accordingly, plans were made and authority was obtained for clearing the flooded area. The lake shore was divided into schedules and a portion of the work advertised for clearing during the fall of 1930. However, bids were so much higher than the engineer's estimate that the work was started by force account during the fall of 1930. During 1931 the heaviest schedules were cleaned up by force account.

Shortly thereafter, because of hard times, clearing operations were discontinued in order to keep down operation and maintenance costs. Meanwhile the E.C.W., now C.C.C., organization was developed. By 1935 the use of C.C.C. forces for this work was authorized. On July 25, 1935, a camp was erected at the lower end of the little lake, just above the "narrows." Because of heavy winter snows and severe weather, the camp was built only for summer occupation, which was first made July 31, 1935. The camp was occupied also during the summers of 1936 and 1939.

In 1936 a new spillway was constructed for the Kachess Dam. This spillway provided for the installation of a radial spillway gate, which would raise the lake surface about 2 feet higher than previously. This gate was installed during the summer of 1937, and the water surface was raised to the maximum high water mark during the springs of 1938 and 1939. In the spring of 1939 this newly flooded strip was cleared by C.C.C. forces. By November 30, 1939, there remained approximately 8 weeks' work for a full strength company to complete this clearing.

Primarily the work consisted of clearing about 900 acres, about one-half of which had been completed by operation and maintenance and construction forces. This work was extremely hazardous, not only because of its nature, but also because of its inaccessibility. The lake shore was readily approachable from only three points. Furthermore, the lake is at times subject to severe squalls, making travel by boat at times both difficult and dangerous. Considerable travel by water was necessary in order to perform the work. This was accomplished with a 28-foot storage O. & M. launch and ten 16-foot metal boats propelled by 5 outboard Evinrude motors of

Upper end of Lake Kachess. Reservoir area cleared and timber piled ready for final disposal



about 4 horsepower. A raft, towed by the launch, was also constructed for moving both men and machinery about the lake.

Enrollee Training

Before starting work, the enrollees were trained in fire fighting by experienced foresters, thoroughly instructed in the use of tools and equipment, and given both on-the-job and off-the-job training. Special attention was called to the use of axes, saws, sledges, wedges, peavies, and life preservers. They were taught how to carry tools through the woods to prevent injury to themselves and others, how to handle saws when timber bound, how to buck logs in all positions, and how to properly fell trees without injury to their tools, to themselves, or to others.

They were taught the mechanics of block and tackle, and the mechanical advantage gained by the use of certain combinations of blocks. Qualified enrollees were taught the methods of high rigging, how to safely climb and rig high poles, and also when and where to oil the different blocks. They were thoroughly trained in the handling of trucks, tractors, hoists, and other equipment. Qualified enrollees were also taught the use of the outboard motors and safe methods in handling the boats. Such enrollees were required to be good swimmers and to wear life preservers while working in the boats. In addition, all enrollees traveling by water were equipped with life preservers and were instructed in their use.

Methods Used in Clearing

The object in clearing the reservoir area was to fell, pile, and burn the dead timber and debris with as little handling as possible. The lake shore was strewn with floating debris, consisting mostly of bark, branches, stumps, and logs. Filling of the reservoir each spring covered portions of the area previously cleared, with this debris. Portions of the shore line were steep, rocky, and poorly accessible for removing debris. In felling the timber, the enrollees were placed far enough apart to prevent accidents by one set felling timber on the other. Piling was done either by hand or power. As soon as practicable after piling, the debris was burned. All men working in the timber were equipped with calked shoes, which permitted them to climb over logs and debris with minimum danger of slipping or falling.

Upper end of Lake Kachess before beginning the clearing operations by CCC enrollees

A good band piling crew consisted of about 20 men working under experienced supervision. The logs were decked as closely as possible after cutting to lengths that could be handled. Logs too heavy for one man were carried to the pile with timber carriers. The logs were rolled into the pile with skids. The piles were usually 8 to 10 feet high. Twenty-horsepower tractors were found very useful for yarding the logs to the piles and for decking the heavier logs. Small logs, branches, and debris were placed at the ends of the piles to aid in the burning. Wet or water-soaked logs were placed on top of dry logs to insure a cleaner burn.

Piling with Power

Power piling was accomplished with the use of gin poles or jammers. The gin pole consisted of a pole, usually vertical but sometimes leaning, or a standing tree located in the desired position. The pole was held in position by a number of guys, usually five, consisting of wire rope of about one-eighth of an inch greater in diameter than the rope used in the rigging. These guys radiated from the top of the pole and stabilized it for use with blocks. The jammer consisted of an A-frame, mounted on one end of a sled and so constructed that it could be set at any angle or let down, and the whole thing moved by a power unit to a different location. When piling, the power unit was usually mounted on the other end of the sled. When in use the A-frame was raised and guyed, usually with four wire ropes. The power units consisted of double drum hoists, caterpillar tractors equipped with double drum hoists, trucks, and 20-horsepower tractors. When the trucks and small tractors were used for power, the power units were not stationary and were therefore not mounted on the sled.

Logs were drawn to the gin poles or jammers by using either a plain choker or a self-releasing choker. Because of danger of injury to the men, the self-releasing choker was used whenever possible.

The poles used were sound timbers, usually about 60 feet long. Piles made with the vertical poles had the appearance at a distance of huge ant hills. The main objection to this type of piling was that the piles did not burn as efficiently as when decked. Burning was particularly poor at the toes of the pile. To overcome this, all light material was pil closely against the toes of the piles. Timber piled with a leaning gin pole were decked a closely as possible. Logs piled in this manner burned readily and did not require muc reclmaking.

Piling with Jammer

Piling with the jammer was very similar t that done with the gin pole, except that th logs to be piled were drawn directly toward the A-frame. Sometimes the logs were closely decked, but ordinarily they were drawn up t the A-frame and released. Building the pile was accomplished by the use of a plain choker or a self-releasing choker. Another satisfactory method was to use logging tongs with short grips. These tongs were similar to ice tongs. The log was drawn to the pile and then raised off the ground and quickly released. As the lower end struck the ground the jar disengaged the tongs, which were then pulled back by hand before taking hold of the next log to be piled. The height of the pile was limited to the height of the A-frame. In piling with both jammer and gin pole, a minimum crew of four men was used as follows: One power operator, one signal man, and two chokermen. For work where the debris was piled near the lake surface in narrow fringe, the use of the jammer was ideal.

Burning

All piles were so located that burning would create a minimum fire hazard. Before work was started on a given area, the advice of the local district ranger of the United States Forest Service was sought and arrangement of piles was gone over in the field with him. This method developed a cooperative spirit, and the district ranger was kept in touch with the prevailing fire hazard.

Before burning, during the fire season, a permit was obtained from the district ranger. Most of the burning was done at night to keep the fire hazard at a minimum. Before burning, fire lines were constructed, fire pumps were installed, hose was laid, portions of the ground wet down, and all possible precautions taken to prevent fire spreading. Crews were kept with the fires until the piles were consumed. As soon as the heat had left the piles sufficiently to permit, the unburned debris was chunked up and shot with powder. Shooting the logs not only split and splintered the wood, but drove the moisture from the timber. Some logs had to be shot several times before they would completely burn.

Progress of Work

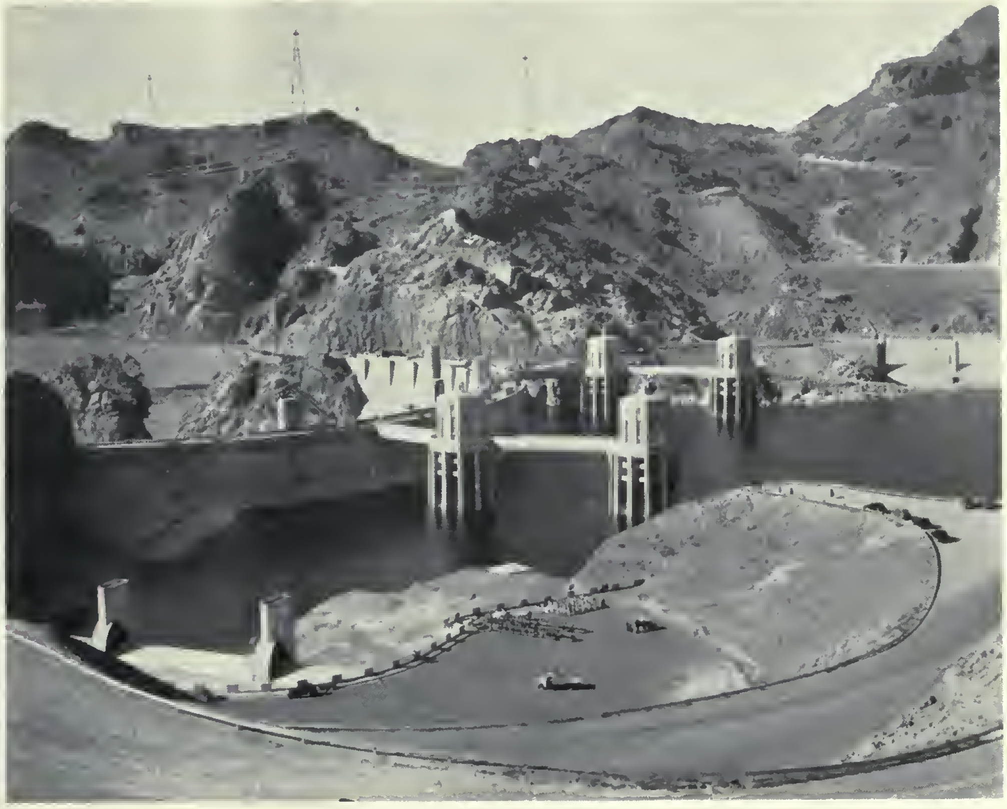
Field work by C. C. C. forces was first started on August 12, 1935. Construction of the camp delayed earlier prosecution of the work; hence it was too late to accomplish much clearing during that year. However, several stands of heavy dead trees near the camp were cleaned up, and some little progress was made up the little lake from camp. For the period worked, excellent progress was made. Forty acres were cleared, 70 acres partially cleared, and 5,668 man-days were used before the company evacuated camp on November 1, 1935. During the winter the camp was maintained under the care of a watchman.

On June 1, 1936, the camp was again occupied. Heavy accumulations of debris at the lower end of the big lake and at the upper end of the little lake were cleaned up. In addition, all standing timber then flooded was felled and bucked, and the shores of the little lake cleaned up. When the camp was evacuated on October 12, 1936, 15 acres had been completed and 119 acres partially completed, with the use of 7,509 man-days. After October 12, 1936, until May 21, 1939, no clearing was done. On May 17, 1939, the camp was again occupied, and clearing started on May 22. This clearing was continued until November 6, 1939. On November 7, the company moved out, after clearing 394 acres, with the use of 10,439 man-days. On this date the camp was again placed under the care of a watchman. There has been expended on this clearing to date 23,616 man-days. It will take an estimated 7,000 man-days more to complete this work. All felling and most of the bucking have been completed, so that it only remains to clean up the shore line.

Death of Robert M. Price

IT IS with regret that the Washington office notes in the latest report from the Truckee storage project the death in January of Robert M. Price, attorney for the Washoe County Water Conservation District. Mr. Price will be greatly missed throughout the project and as an official of the district, as he was always found to be cooperative, genuine, and sincere.

Boulder Dam Amphitheater



MAY we present the Boulder Dam Amphitheater? When the dam was used on January 17 as "Convention City" for the Rotary Clubs of Las Vegas and Boulder City including officers of 46 other southwestern clubs, a less frequented spot near the dam was selected for the occasion. Nested against the sloping Arizona Canyon wall is a natural amphitheater, a broad paved area overlooking the dam, the spillway, the intake towers, and Lake Mead. Here, sheltered from desert wind by the sloping terrain which proves also a sounding board, the 100 or more members gathered, away from the beaten trails, but within view of all the interesting features unique to Boulder Dam.

The spot, now called Boulder Dam Amphitheater, offers opportunities for many such gatherings in the future. Few famed outdoor amphitheaters offer the combination found here of privacy, spaciousness, natural acoustics, and painted scenery, tucked beside the world's greatest engineering structure, and overlooking a reservoir which offers boating, swimming, and fishing for moments of relaxation. Even the spillway is big enough for a football field. Did we hear someone mention a Boulder Bowl?

Idaho Weed Program

By **H. L. SPENCE, Jr.**, *Extension Agronomist*

NOXIOUS weed infestations have long been one of the greatest farm problems in Idaho, and their control and eradication is vitally necessary if successful farming is to be continued. No single farming requirement demands such universal and increasing attention as do weeds. The expense of fighting weeds represents the largest part of the labor costs required in producing crops. The seriousness of this problem has been evidenced in Idaho by the widespread interest of farmers and businessmen alike, and in their efforts to obtain the establishment of a comprehensive State-wide weed control program.

For the past 4 years Idaho farmers have been cooperating with the first State-wide noxious weed eradication program to be undertaken by any State. During this period of time, more than 60,000 acres of perennial noxious weeds have been brought under control, which in return has added hundreds of thousands of dollars to land valuations within the State. No one program has ever met with such universal support from both farmers and businessmen in the history of the State, and with the solid foundation now molded, this program stands to remain until the serious problem of noxious weeds is brought under permanent control.

Idaho is a comparatively young State, having enjoyed statehood for the relatively short period of 50 years. During this same period of time, the major portion of the agricultural industry in the State has been developed. The entire southern two-thirds of the State is made up primarily of irrigation projects, most of which have been established less than 40 years. At the time these projects were open to settlers, serious weed pests were unknown, as the lands were made up of virgin desert areas which were brought into bloom as irrigation water was made available.

Supplies of crop seeds were brought into the State to plant these new lands, and with these seeds came the first noxious weeds. Plants which are native to a country seldom have been known to become serious weed pests, but when transplanted to other environments they often become disastrous pests. This fact is clearly evidenced when we consider that in excess of 99 percent of our present weeds have been introduced from foreign countries. Weeds arrived with the first immigrants from the Old World. From these early times the spread of weeds has been traced until today every county is well infested. Alfalfa seed from Russia and Turkestan; vegetable and flower seeds from the Netherlands, France, Germany, and England; grasses from Australia and New Zealand; soybeans from the Orient, and ships' ballast from every port in the world; all have contributed heavily to infest our fields with new weed pests.

As the seriousness of weed infestations became apparent, the experiment stations took up the problems of working out control and eradication measures. Such a program was conducted by the Idaho experiment stations from their earliest establishment, but the problem did not receive major emphasis until about 1925. During the past 15 years, the experiment stations and the Extension Division have placed major emphasis upon the problem of controlling noxious weeds. Many materials and methods were tested and discarded. Promising means of control and eradication were taken into the field, and demonstrations set up in every section of the State to show farmers how this problem might be met. During the same period, an extensive educational program has been conducted to bring about full recognition of the seriousness of the weed problem to both farmers and businessmen throughout the State. Recognition of the seriousness of noxious weeds by farmers is more than 50 percent of any weed battle.

State Weed Law

The demand for action, following general realization of the seriousness of the problem, culminated in the establishment of a State weed law, which set up the machinery by which the problem could be met. Briefly the Idaho weed law requires that each board of county commissioners create a part, or the entire county, into a weed district. Weeds which are considered noxious are named, and methods of control and eradication specified. A date is prescribed by which time the individual landowner must destroy any noxious weeds growing upon his properties. If the individual owner should fail to do so, the county then has the legal right to send crews onto the property and to destroy any noxious weeds found growing there, the cost of which work is assessed to his taxes. Following the passage of this law, numerous individual counties in Idaho established county programs in an effort to combat the weed problem. It was found, however, due to excessive costs of known methods of weed eradication, that the program could not be financed by the county or the individual landowner on a scope sufficiently large to deal with the problem.

Early in 1933 the committee representing leading farm and civic organizations was organized for the purpose of investigating possibilities of obtaining State and Federal aid for weed eradication. The work of this committee resulted in the approval, during the spring of 1936, of a $1,000,000 weed project, by the Works Progress Administration. Since

One of 30 cultivator units operated under the Idaho weed program during 1939. Each infested field is cultivated every 12 days

that time, two supplemental projects have been approved in amounts totaling in excess of $3,000,000. In addition, the Idaho State-wide weed program has been supplemented with State funds amounting to $100,000 during 1937–38, and $150,000 during 1939–40. The various county contributions to the program have further supplemented these funds with approximately $750,000. After 4 years of extensive operation of the weed eradication program, Idaho farmers for the first time stand in a position to overcome the large losses caused by infestations of noxious weeds.

Experienced Supervisors Selected

In organizing this first State-wide weed program, supervisory personnel was selected among workers who had had experience on local county projects. A State weed supervisor, together with three district weed supervisors, was appointed to supervise the work in the various counties, and to coordinate all activities. In addition, a county weed supervisor, and a number of field men were employed, who operated the work crews in the various counties. This entire personnel was selected from the nonrelief rolls, and salaries and expenses were paid from W.P.A. allocations. In addition, some 2,000 W.P.A. relief workers have been employed throughout the State in carrying out the various prescribed methods of weed control.

Noxious Weeds

Three objectives were set up as a goal for the first year's operation, namely; (1) the completion of a farm to farm survey in each county, locating and mapping all infestations of noxious weeds. Such a survey is a vital necessity before definite long-time objectives can be established. In Idaho this survey not only furnished the first accurate picture of the area infested with noxious weeds, but also brought about the discovery of several new weeds, which, had they not been destroyed, would have greatly increased the weed burden, (2) treating chemically all small scattered patches of noxious weeds, and (3) the establishment of clean cultivation programs on large infestations where chemical control was impractical due to cost. In addition to furnishing the supervision and labor for conducting the program, the Works Progress Administration also furnished up to 50 percent of the chemicals used under the program. With these contributions the cost of weed eradication in Idaho was reduced to a practical basis which stimulated the landowner's desire to cooperate in cleaning up any weed infestations on his lands. During the past 3 years, reductions in W. P. A. funds have caused decreased participation in the furnishing of chemicals. This, however, has been offset by State and county participation, which has permitted the cost to the landowner to remain approximately on the same basis.

Applying carbon bisulphide with new weed gun which reduces labor cost almost 50 percent

The principal weeds which are considered noxious, and which were concentrated upon under the program include: White top, morning glory, Canada thistle, perennial sow thistle, Russian knapweed, leafy spurge, perennial ground cherry, yellow toad flax, blue flowering lettuce and quack grass. Surveys completed under the program show a total infestation on agricultural lands in excess of 200,000 acres. In addition to this figure, infestations are known to occur on forest and grazing lands in many sections of the State. While some effort has been made under the program to develop water shed programs for the destruction of noxious weeds on these areas, this phase remains one of the important objectives yet to be worked out.

Eradication Methods

Three methods of weed eradication which have proven successful under Idaho conditions were selected, and have been emphasized under this program. Chemical weed control for small areas has been accomplished with the use of sodium chlorate and carbon bisulphide. Sodium chlorate is used largely for waste areas, roadsides, ditch banks, on dry farm or semihumid areas of the State. Carbon bisulphide has been the choice of landowners and used exclusively on the high-valued, productive, irrigated lands. This is due largely to the fact that little or no sterility occurs from the use of this material. The cost of carbon bisulphide is double that of sodium chlorate and its use is confined to relatively small infestations. The third method of weed eradication in Idaho, that of clean cultivation, is the oldest known method of weed control and eradication, and remains the only practical answer to large infestations. In order to obtain maximum results with this method, it must be carried out on a systematic schedule. Many farmers who have attempted to undertake such a program themselves, have failed because the work was done in a hit or miss fashion, rather than on a set schedule. For this reason, it was found desirable to purchase county owned tractors and cultivation equipment which were operated exclusively under the weed project on a definite schedule. In excess of 30,000 acres of noxious weeds have been handled under this phase of the program during the past 2 years. Each farm entered under the clean cultivation program is signed up under a 3-year contract, with the first 2 years devoted to intensive cultivation, and the third year planting to a check-row crop so that stragglers may be easily spotted and eradicated by chemical means. The cost of this work in Idaho, where county units have been employed, has averaged approximately $12 per acre for the entire period.

Four years of experience in the operation of this extensive program in Idaho have led to numerous changes, which in turn have greatly stepped up its efficiency. Many landowners who at the start of the project were highly skeptical as to results, are now its most ardent backers. A real weed-conscious condition among farmers is now present throughout the State and it is extremely doubtful if the project could be abandoned before the weed problem in the State is brought under complete control.

Colorado Big Thompson Project Headquarters Camp Vacation Land

By GOLDIE L. BEZOLD

THE Government camp of the Colorado-Big Thompson project at Estes Park, Colo., is located on the south side of the Big Thompson River about 700 feet up the slope. This triangular area is at the junction of the North and South St. Vrain Highways which lead to Denver via their respective canyons.

At the apex of the triangle is the administration building. This is an attractive colonial type structure with a pillared portico across the front. Close by is the 12-man dormitory and the official garage. Still farther back of the administration building, the white residences with their red, green, and gray roofs, house the families of the Government employees. There are 24 permanent residences of colonial or semicolonial type and 12 temporary duplex cottages. The charming simplicity of these homes, each of which has a fireplace, adds much to the beauty of the camp which will be seeded to grass in the spring. The landscaping, in many places terraced along the contours of the slope, has been finished. Streets have not yet been surfaced.

When this work is completed, a more pleasant home site could not be desired, for here is one of the most beautiful of the innumerable mountain parks in Colorado. This park, the common name for the far flung open spaces within the mountains themselves, comprises some 100 square miles and is approximately 8,000 feet in altitude.

The rugged mountains surrounding it point their jagged fingers far into the sky. Their sides are slashed with dark canyons and their unscalable cliffs catch the brilliant sunshine which bathes them by day in glorious amber and at sunset turns their snow-covered peaks to amethyst and rose.

The majesty and grandeur of the storms which sweep up their rough sides to swirl snow in screaming blasts around their tops, the gray mists which hang like a veil between them and the valley below, or the clouds which brush their crags in fearless familiarity—this ever-changing beauty is for anyone who cares to lift his eyes.

Longs Peak

Sentinel of this paradise of loveliness is Longs Peak with an altitude of 14,255 feet. This is perhaps the most notable peak of the hundreds of this approximate elevation in Colorado. Perhaps the historic reason for its fame is that it could be seen for 150 miles out on the plains and stood as a bold landmark to early travelers crossing the western parts of the United States.

This peak, known as Two-Ears by the Indians, was first seen by Lt. Z. M. Pike in 1806, and in 1820 by Col. S. H. Long who was sent out by President Madison on an exploring party. Neither Pike nor the man for whom the peak was named, however, attempted to climb it. It is here that the Big Thompson and St. Vrain Rivers have their sources.

Its easy accessibility is perhaps its second claim to fame. Climbers, mere children of 8 or 10 to adults well up in their seventies, have been known to reach the top. Although the last few hundred feet is at a roof-pitch slant, all but the last 2 miles can be made on horseback. The lives lost in its ascent or descent have been due, for the most part, to the venturesome spirits of those who prefer the hard way of doing things.

The region surrounding the Government camp is a rich strike for nature and sports lovers. Flowers, hundreds of specimens, splash the mountain sides like paints spilled from huge color pots. Their type and variety change with the seasons as well as at different altitudes. Vegetation of both the alpine and artic types is found at the higher ranges.

As a game preserve elk and deer in large herds are a common sight. The beaver, that first reclamation engineer, still works faithfully here at his profession. Big Horn sheep and bear, though present, are rarely seen even from Trail Ridge Road, the highest continuous highway in the United States. This road, a monument to modern-day engineering, affords an easy method for travelers to gain an unobstructed view of the magnificent distances below.

A vacation paradise, this section draws people from all parts of the world. In summer there are uncounted, hidden places yet to be discovered either on foot or horseback. Clear mountain streams claim the fisherman with the ever-enticing promise of the big one to be tricked from his cool retreat around the next bend of the creek.

The mild winters and wide variety of slopes make skiing available to all, and the many lakes furnish skating rinks in stage settings which could be planned only by the master artist.

It is doubtful whether any other reclamation project has a more beautiful location, and for those who love the outdoors, it is a rare opportunity for living close to the overflowing bounty of which Mother Nature gives so lavishly and unstintingly in Estes Park.

A Gem From Reclamation Archives

NEARLY 42 years ago Frederick H. Newell, then chief of the Hydrographic Division of the Geological Survey, and later the first director of the Reclamation Service, wrote the following article which was published in The Independent of August 11, 1898:

"THE ANNEXATION OF THE ARID WEST

"Now that annexations of territory are under consideration, and the utility of various tropical islands a matter of current discussion, it should not be forgotten that the United States Government already possesses a princely domain which, for all practical purposes, is still as legitimate a subject for annexation as any new country in the world. One-third of the area of the United States is owned by the general government, or about two-thirds of the territory between the 100th meridian and the Pacific coast. The greater part of this immense area is, in its natural condition, worthless for agricultural purposes, and hence does not furnish homes for our growing population. Yet this land is the most fertile in the world, and water, the only thing which it lacks, can be supplied. The farm lands of the East, and of the humid regions of the world generally, besides being more or less exhausted by constant cultivation, have for ages been washed by copious rainfalls. In the West, where freshets have not robbed the soil of its mineral salts, fertility has for centuries been accumulating, with the result that today, under proper irrigation, *four acres of land, producing three to five crops a year, can be made to support a family;* while in the other farm lands of the world a hundred acres is often insufficient. A small piece of our arid land, devoted to semitropical fruits, garden vegetables, and forage plants, under irrigation produced wonderful results.

"In nearly all of the arid region, irrigation is not only feasible, but has been proved successful. It is not always financially profitable to the private corporation looking for eight percent dividends; but in the same sense that a lighthouse, the dredging of a harbor, or the improvement of a river is profitable, it would pay the community or the general government to open this great area for agricultural use, and so make it the comfortable home of millions of prosperous people. Irrigation is one of the simplest processes in the world, and its fundamental methods have changed little since the time of the Pharaohs. It is simply the storage and gradual use throughout the year of the floods which come at a particular season, usually in May and June, and go to waste. Artesian wells are in some instances successfully employed; but the main reliance in the West will probably continue to be the surface water. Altho the system itself is so old, modern science knows comparatively little of the relation of water to the development of vegetable life, or why we apply water to the soil. It is known, for instance, that water may be so supplied to potatoes as to make them small in size and many in a hill, or by a different application of water they may be made few and large. Water given in quantity to grain at a certain stage will make the crop run to straw. Similar observations in the case of fruit trees are equally familiar; but the whole subject rests upon individual experiences rather than scientific certainty. An accurate knowledge of water effects will form the basis of the intelligent practice of irrigation. Already the agricultural stations in the West are making experiments in this line, under the direction of Dr. A. C. True, and from them important results may flow.

"Our land laws are not the most favorable to the development of irrigation. The plotting is now done on the rectangular system, which is adapted to humid country, where one quarter section is as well watered as another. But where the rivers are few it may happen that one quarter section will embrace all the water obtainable for a thousand sections. The man who then gets control of the water-hold is master of the situation, and those who come after him get nothing, because water in the arid regions is the foundation of value, and without it land is worthless. To avoid this result our public land should be divided in reference to its water rights, and thus give every settler a chance at its reclamation.

"In the early days of the Republic, when times were hard, the men who felt crowded in the East, or who preferred the larger venture of pioneer life, packed up their goods in a four-horse wagon and started "out West," to the Ohio reserve or to Indiana; but these conditions have wholly changed. Altho there is plenty of public land left, most of it is useless until, by the united effort of a large number of individuals, or of the Government, a water supply is provided. The Mormons went out to Salt Lake, and by community effort have accomplished wonders; but even opportunities of that kind rarely exist. The sources of water supply now are the great rivers, which can be diverted only by the expenditure of hundreds of thousands, and often millions of dollars. Such outlays would be well repaid, however, if undertaken by the Government in a systematic fashion, when the sociological results and industrial advantages are fully estimated. Irrigated lands tend to produce a splendid civilization. Where land is so fertile that little of it is needed for one pair of hands, a closely settled community of small proprietors generally grows up. People can live just near enough together to have the advantages of good schools, churches, and those wholesome associations which flow from community life, and at the same time be free from the depressing influences of the great city. What conditions could be more favorable?

"Irrigation is beginning to receive some share of the public attention that is its due. The Seventh Congress, which will be held in Cheyenne in the autumn, promises to attract more interest than any of its predecessors. Governor Mount, of Indiana, has set forth, in a recent letter, the bearing of the subject upon the welfare of the Nation in words which I cannot do better than to quote. He writes:

" 'Two important problems are before us—the unemployed and our arid lands. A policy that would furnish to the idle remunerative employment, and fruitfulness to our desert places, would prove a boon to our country and a blessing to humanity. A policy that would relieve the congested cities and supply their crowded inmates with homes; that would develop manhood and womanhood, furnishing employment, teaching habits of industry and

(*Continued on page 90*)

● *New sound movie available for booking.*—A three-reel sound motion picture, Fundamentals of Irrigation, has been released by the Bureau of Reclamation and is now available for immediate booking. The film may be obtained in 16- or 35-mm. sound print. Running time is 30 minutes.

In interesting scenes filmed on Federal Reclamation projects, the motion picture presents modern irrigation methods that conserve soil, plant food, and water and pay in the production of higher quality crops and larger yields. Here are seen in operation time- and labor-saving equipment for preparing land and laying out the irrigation system. Also shown are practical control structures, many of which may be made on the farm from inexpensive materials.

Laboratory demonstrations illustrate how water moves by gravity and capillarity in different type soils. By animation is depicted how water moves into the soil during and after irrigation and how overirrigation contributing to a high-water table results in capillary rise of water, causing waterlogging of the land and alkali problems. Animations also picture the movement of water into the soil along a field run and the effect of length of run on evenness of penetration. The concluding scenes show how a farmer can determine when to irrigate and how much water to apply.

Requests for the film may be addressed to the Commissioner, Bureau of Reclamation, Washington, D. C. As there are a limited number of prints, requests should be made considerably in advance and should specify whether 16- or 35-mm. sound print is desired, and places and dates of showing, giving three optional dates in order of choice. No rental charge is made for the film, but the exhibitor is asked to pay express charges.

Home on a reclamation project

Arizona Desert

An irrigated farm

Farm and Home Opportunities

FARM owners on Reclamation projects who desire to dispose of their properties, also persons seeking information as to available improved irrigated farms, would seem to be served by the inauguration of this *Farm and Home Opportunities* feature of the ERA.

In this section will be carried listings sent in by owners. *The facts presented are subject to verification, as the Bureau of Reclamation cannot undertake this task, and cannot be responsible for the accuracy of representations made.* Interested persons should communicate direct in accordance with the information contained in listings.

The Bureau's helpfulness in attempting to bring together buyer and seller is primarily designed to reduce tenancy, settle vacant farms of nonresident owners, and aid in the adjustments found necessary when a farmer and his family must change to a different locality. Satisfied owners on Federal reclamation projects are an asset to the Bureau of Reclamation. Anything the Bureau can do to bring about full settlement of vacant farms and improve the economic status of settlers is in the interest of the Government, as they are under contract to repay the cost of irrigation works.

Listings should be cleared through project offices shown on the inside of the back cover.

Yuma Project, Arizona

Description of farm	Price and contact	Remarks
30 acres. Heavy river loam; no alkali; more than average productivity; on improved road 2 miles from paved road; well levelled; fenced.	$150 per acre; $1,000 down, balance $500 annually at 6 percent deferred. Owner: Pearl F. Beaman, 306 Third St., Yuma, Ariz.	House; 4 miles from Yuma on Main Canal; 350 pecan trees; alfalfa and cotton yield high; suitable for dairy, vegetables, cotton, maize, etc.
17 acres, N½NE¼SW¼ sec. 29, T. 8 S. R. 23 W. G. & S. R. B. & M. Alluvial soil; no alkali; average productivity; on improved road about 1 mile from paved road; levelled; fenced.	$382 per acre; $1,500 down, balance $300 per year. Owner: Bank of Beaumont, Beaumont, Calif.	No house or corrals; citrus and pecans.
38 acres, unit M in Bard Irrigation District, NW¼SW¼ sec. 5, T. 16 S., range 23 E., S. B. B. & M. Alluvial soil; no alkali; average productivity; on improved road about 2 miles from paved road; reasonably levelled; unfenced.	$47 per acre; $450 down, balance $250 per year. Owner: Bank of Beaumont, Beaumont, Calif.	No house or corrals.
39 acres, 7 miles from Yuma on paved road.	Price $4,000. Owner: Federal Land Bank of Berkeley, 15th and Clay Sts., Oakland, Calif.	No buildings.
20 acres, S½SE¼NE¼ sec. 12, T. 9, R. 24. Sandy loam; no alkali; average productivity; paved road; well levelled; fenced (sheep wire, steel posts).	$200 per acre; $2,500 down, balance $1,500—20 years. Owner: Wm. Castleton, P. O. Box 83, Yuma, Ariz.	House, corrals; pecans, citrus, dates, figs.
40 acres, 30 irrigable; NE¼SW¼ sec. 35–9–24. Sandy loam; no alkali; more than average productivity; ¼ mile to paved road; well levelled; fenced.	Price $3,000; terms. Owner: Eugene Clymer, P. O. Box 1443, Yuma, Ariz.	4-room house, corrals, chicken pens, windmill with tank, water piped to house and corral; 10 acres sand hills; 11 acres pecans; 25 acres alfalfa.
40 acres, no alkali; average productivity; on improved road; well levelled.	Price $4,500, enough down for a sale. Owner: Walter J. Coats, Plains, Kans.	House.
30 acres, NE¼SE¼, sec. 4-9-24. Sandy loam; no alkali; average productivity; on improved road, ¼ mile to paved road; well levelled; unfenced.	$133.33 per acre; cash. Owner: C. A. Converse, R. F. D., Somerton, Ariz.	Small house; 20 acres in pecan trees.
40 acres, NW¼NE¼ sec. 20, T. 9 S., R. 24 W., G. & S. R. B. & M. Farm unit B. Sandy loam. No alkali, but has about 3 acres high land. Average productivity. On improved road ¼ mile to pavement. Well levelled and fenced.	$95 per acre; 10 percent down; none to man with plenty of stock and tools; balance over long term. Owner: Mary C. Demund, 710 W. Washington, Phoenix, Ariz.	House.
48.92 acres, farm unit Q, 16–16–23. Medium soft soil; trace of alkali; good productivity; on improved road; about 2 miles to paved road; well levelled and fenced. Lot 7, 39 acres; lot 10, 9.92 acres.	Price $4,500; $1,500 down; balance 5 years or amortize 1 percent interest deducted monthly, making monthly payments of $30 including interest. Owner: Hubert R. Dodd, 2227 Talmadge St., Los Angeles, Calif.	House and 1 corral.

Yuma Project, Arizona—Continued

Description of farm	Price and contact	Remarks
80 acres, E½NW¼ sec. 11, T. 9 S., R. 24 W., G. & S. R. M. Yuma Co. Imperial loam and imperial sandy loam; alkali spots on about 10 acres; trace only on remaining 70 acres. More than average productivity; on paved road; very well levelled and fenced.	$100 per acre; $2,500 down; balance in 5 equal annual payments. Owner: Emil C. Eger, Yuma, Ariz.	House; this land recently levelled; has been in alfalfa and cotton and growth of cover crop thereon showed soil had lots of strength; each 40 acres of land waters through separate main canals; land is well drained and maximum fall per land is 3 inches or less; concrete gates throughout.
67.04 acres, E½NW¼ sec. 11-9-24. Imperial loam. About 10 acres now being reclaimed show alkali spots. More than average productivity. On paved road; well levelled and fenced.	$115 per acre; ¼ down; balance in 4 years. Owner: Emil C. Eger, 14 Second St., Yuma, Ariz.	House and corrals.
40 acres, 4 miles from Yuma on State Highway 95.	Price $5,500. Owner: Federal Land Bank of Berkeley, 15th and Clay Sts., Oakland, Calif.	3-room dwelling, modern plumbing; part in alfalfa; shade trees.
80 acres, 9 miles from Yuma on paved road.	Price $5,000. Owner: Federal Land Bank of Berkeley, 15th and Clay Sts., Oakland, Calif.	3-room dwelling with screen porch; electricity; shade trees; part in alfalfa.
80 acres, 6 miles from Yuma on graveled county road.	Price $3,000. Owner: Federal Land Bank of Berkeley, 15th and Clay Sts., Oakland, Calif.	Dwelling 20 x 36, with screen porch on 3 sides; shade trees; 60 acres plowland.
80 acres, 2½ miles from Yuma.	Price $10,000. Owner: Federal Land Bank of Berkeley, 15th and Clay Sts., Oakland, Calif.	6-room adobe dwelling; 40 acres pecans, balance plowland.
80 acres, 4 miles from Somerton.	Price $6,000. Owner: Federal Land Bank of Berkeley, 15th and Clay Sts., Oakland, Calif.	2 small dwellings; telephone; electricity; shade trees; 75 acres alfalfa.
10 acres, farm unit F and V, Yuma Mesa. Sandy soil; no alkali; more than average productivity; on improved road, 3 miles to paved road; well levelled; unfenced.	$1,100 per acre; $8,000 down; balance $3,000 in $600 yearly payments at 5 percent. Owner: Lillian Fritz, P. O. Box 287, Yuma, Ariz.	No house nor corrals; marsh; seedless grapefruit.
40 acres, unit A, NE¼ sec. 35, T. 15 S., R. 23 E., S. B. B. M., Imperial Co., Calif. Sandy soil; alkali spots; excellent productivity when farmed thoroughly; on improved road about 9 miles from highway; well levelled in part; unfenced.	$100 per acre; at least ¼ down; balance yearly. Owner: Hortense Griggs, 121 Lime St., Inglewood, Calif.	Old house.
20 acres, W½NE¼NE¼ sec. 31-8-23. Sandy loam; no alkali; more than average productivity; on improved road ⅛ mile to paved road; well levelled; fenced.	$300 per acre; $1,000 down; balance terms. Owner: Edwin L. Hansherger, R.F.D., Yuma, Ariz.	House and corrals.
54.3 acres, N½SE¼NE¼ and SW¼NE¼ sec. 12-9-24. Sandy loam; no alkali; average productivity; on paved road; well levelled; fenced.	$135 per acre; $1,000 down; balance, terms. Owner: Edwin L. Hansherger, R. F. D., Yuma, Ariz.	Do.
40 acres, farm unit P, sec. 7-16-23. Adobe clay; no alkali; average productivity; on improved road, 6 miles to paved road; well leveled; fenced.	$200 per acre; 50 percent down; balance 3 years or more. Owner: Bertha M. Hartwell, Route 2, Yuma, Ariz.	Do.
40 acres, farm unit O, sec. 7-16-23. Adobe soil; no alkali; average productivity; on improved road, 6 miles to paved road; 33 acres well leveled; partly fenced.	$150 per acre; 50 percent down; balance 3 years or more. Owner: Bertha M. Hartwell, Route 2, Yuma, Ariz.	Do.
10 acres, NE¼NW¼NW¼ C, sec. 8, T. 10 S., R. 23 W. Sandy loam; no alkali; more than average productivity; on improved road.	$500 per acre; half down payment; balance in 1 year. Contact: Bureau of Reclamation, Yuma, Ariz.	Modern concrete irrigation flumes. Full-bearing grapefruit orchard planted in 1926-27; full water rights.
40 acres, SW¼NW¼ sec. 10, T. 10 S., R. 24 W., G. & S. R. M. Sandy soil; no alkali; average productivity; ½ mile to paved road; fairly leveled; fenced.	$150 per acre; 25 percent down payment; balance, terms to suit. Owner: Dr. C. H. Hunt, P. O. Box 196, Bisbee, Ariz.	House.
40 acres, NE¼NE¼ sec. 26, T. 9 S., R. 24 W., G. & S. R. B. & M. Loam; no alkali; more than average productivity; on paved road; well leveled; fenced.	$125 per acre; $1,000 down; balance, reasonable terms; part Federal Land Bank loan now on it. Owner: J. L. Jones, 133 S. Central, Glendale, Ariz.	Do.
10 acres, NE¼SW¼NE¼, unit L, sec. 6, T. 10 S., R. 23 W. Sandy soil; no alkali; average productivity; ¼ mile to paved road; well leveled; unfenced.	$250 per acre; $800 down; balance 5 percent. Contact: Bureau of Reclamation, Yuma, Ariz.	Adobe house; 2 corrals; 5 acres in production, citrus fruits.
36.96 acres, farm unit C, sec. 34-15-23. Sand and adobe; alkali spots on 4 acres; more than average productivity; on improved road, 10 miles to paved road; well leveled; unfenced.	$75 per acre; down payment, all. Contact: Bureau of Reclamation, Yuma, Ariz.	House.
156.91 acres; lots 3 and 4 and E½SW¼ sec. 7-9-23. Loam; average productivity; ½ mile to improved road; well leveled; fenced; trace of alkali spots.	$225 per acre; $12,000 down; balance, terms to suit. Owner: F. J. Martin, Route 1, Yuma, Ariz.	Good house, small corrals 30 acres alfalfa; 70 acres 10-year old pecan trees rest in grain crops.
76 acres, W½SE¼ sec. 33-8-24. Sandy loam; no alkali; average productivity; 1 mile to paved road; fairly well levelled; unfenced.	$40 per acre; terms cash. Owner: Mortgage Guaranty & Security Co., P. O. Box 96, Yuma, Ariz.	Tent.
10 acres, NE¼SW¼NE¼ sec. 6, T. 16 S., R. 23 E., farm unit E. Loamy; no alkali; more than average productivity; on improved road, 7 miles to paved road; well levelled; fenced.	$500 per acre; $5,000 cash. Owner: J. H. Oghurn, Route 2, Yuma, Ariz.	House and corrals.
38 acres, tract 33, block 15, range 23. Sandy; trace of alkali; on improved road ¼ mile to paved road; well levelled; fenced; average productivity.	$110 per acre; $2,000 down; terms to suit at 6 percent. Owner: E. L. Sadler, P. O. Box 54, Palmdale, Calif.	Do.
20 acres, S½NW¼SE¼ sec. 30-8-23. Imperial sandy loam; no alkali; average productivity; ½ mile to paved road; well levelled.	$135 per acre; ¼ down; balance, 4 years. Owner: Security-First National Bank of Los Angeles, 14 Second St., Yuma, Ariz.	Suburban property.
80 acres, E½SW¼ sec. 25, T. 10 S., R. 25 W., G. & S. R. M. Sandy loam; no alkali; more than average productivity; well levelled; on improved road ¼ mile to paved road.	$150 per acre; $2,000 down; balance reasonable terms. Owner; S. C. 6431 Garvanza Ave., Los Angeles, Calif.	
40 acres, NE¼NW¼ sec. 17-9-24. Sediment; trace of alkali; average productivity; ½ mile to paved road; fairly well levelled; unfenced.	$150 per acre; ⅓ down; balance, terms to suit. Owner: M. G. Silva, 119 Harvest St., Salinas, Calif.	No house nor corrals.
10 acres, unit C, NE¼SW¼SW¼ sec. 4-10-23. Sandy loam; trace alkali; average productivity; on improved road 1 mile to paved road; well levelled; unfenced.	$350 per acre; ½ down payment; balance 5 years. Owner; Michael Strasser, General Delivery, Yuma, Ariz.	No house; corrals; 10-year orchard; oranges, 1½ acres; grapefruit, 3½ acres; alfalfa, 5 acres.
10 acres, farm unit G, SW¼ sec. 29-10-23. Sandy; no alkali; unlevelled; unfenced; average productivity; 5 miles to paved road.	$100 per acre; cash in full. Owner: Elmer Swanson, P. O. Box 1191, Clifton, Ariz.	No house nor corrals.
70 acres, E½SE¼ sec. 24-9-24. Imperial loam; alkali spots on about 5 acres being reclaimed; average productivity; on paved road; well levelled; fenced.	$110 per acre; ¼ down; balance 4 years. Owner: Title Insurance & Trust Co. of Yuma, 14 Second St., Yuma, Ariz.	Do.
80 acres, W½SW¼ sec. 3, T. 9 S., R. 24 W. Imperial sandy loam; no alkali; more than average productivity; on paved road; very well levelled; unfenced.	$115 per acre; $2,500 down; balance in 5 equal annual payments. Owner: Title Insurance & Trust Co. of Yuma, 14 Second St., Yuma, Ariz.	House and corrals. About 15 acres in cotton subsidized by Government; balance in fine stand of alfalfa which produces heavily. Land waters well; levelled in 3½ acre units. Leak-proof patent Government gates, all concrete and check gates throughout.
80 acres, E½SE¼ sec. 24, T. 9S., R. 24 W., G. & S. R. M., Yuma County. Imperial loam soil; average productivity; levelled; fenced; on paved road; land well drained; type that shows marked improvement after each year of farming.	$100 per acre; $2,500 down, balance 5 equal annual installments. Owner: Title Insurance & Trust Co. of Yuma, Yuma, Ariz.	House, corrals. Has been in alfalfa for many years. Soil has lots of strength. Irrigates well. Concrete gates throughout.
90 acres, NE¼ of sec. 28, north and west of main drainage canal, T. 9, R. 24. Yuma Valley silt loam; trace alkali spots; average productivity; average productivity; on improved road ½ mile to paved road; fairly well levelled; fenced.	$50 per acre; $2,500 down; balance to suit. Owner: J. J. Waddell, 48 Third St., Yuma, Ariz.	Small house, corrals. Part of land lying next to the drainage seeps part of year. Land would make exceptionally good general farming proposition with stock, etc. Main drainage canal gives adequate supply of fresh running water every day in year. Ideal for cattle, hogs, and sheep. Most of land is adaptable for alfalfa, flax, and other grains.
40 acres, unit B, NE¼SE¼ sec. 30-9-24, G. & S. R. M. Sandy loam; no alkali; average productivity; 1¼ miles to paved road; fairly well levelled; unfenced.	$50 net per acre; $500 down; balance yearly. Contact: Bureau of Reclamation, Yuma, Ariz.	House and corrals.

Yuma Project, Arizona—Continued

Description of farm	Price and contact	Remarks
9.4 acres, Pt. SW¼SW¼ sec. 34–9–24. Sandy loam; trace alkali spots; more than average productivity; well levelled.	Owner: L. W. Williams, P. O. Box 83, Somerton, Ariz.	Tract just outside city limits of Somerton, Ariz. Produced 3,500 pounds alfalfa seed in 1939.
40 acres, lot 1, sec. 7, T. 16 S., R. 23 E., S. B. M., Imperial County, Calif. Sandy; no alkali; average productivity; 4 miles to paved road; unlevelled; unfenced.	$25 per acre; $250 down: balance reasonable monthly payments. Owner: Eugene F. Wolver, 318 W. 9th St., Los Angeles, Calif.	1 room adobe house.
40 acres, farm unit Q, SE¼SE¼ sec. 5, T. 16 S., R. 23 E., S. B. M., Imperial County, Calif. Sandy loam; no alkali; more than average productivity; on improved road; well levelled; unfenced.	$1,000 down; balance, 3-year period; price $2,500. Owner: Joseph P. Wrenn, 711 Equitable Bldg., Hollywood, Calif.	House and corrals.
37 acres, farm unit H, sec. 5–16–23. Sandy loam; no alkali; more than average productivity; 7 miles to paved road; well levelled; unfenced.	$200 per acre. Owner: Mrs. Maggie Booza Wright, 206 N. 10th St., Okemah, Okla.	House.

NOTES FOR CONTRACTORS

Specification No.	Project	Bids opened	Work or material	Low bidder		Bid	Terms	Award
				Name	Address			
887	Colorado-Big Thompson, Colo.	1940 Jan. 4	Power transformers, switching equipment, step-voltage regulators and lightning arresters for Brush, Fort Morgan and Wiggins substations.	Allis-Chalmers Manufacturing Co.	Milwaukee, Wis.	[1] $550.00	F. o. b. destination; shipping point, Pittsburgh, Pa.	1940 Feb. 12
				Kelman Electric and Manufacturing Co.	Los Angeles, Calif.	[2] 3,323.00	F. o. b. destination	Do.
				General Electric Co.	Schenectady, N. Y.	[3] 16,707.00	F. o. b. destination; shipping point, Pittsfield, Mass.	Feb. 3
				Pacific Electric Manufacturing Corporation.	San Francisco, Calif.	[4] 6,170.00	F. o. b. destination; shipping points, San Francisco, and either Baltimore or Barberton, Ohio.	Feb. 12
				Bowie Switch Co.	do	[5] 1,482.30	F. o. b. destination	(12)
				Royal Electric Co.	Chicago, Ill.	[6] 939.00	do	Feb. 12
				Graybar Electric Co.	Denver, Colo.	[7] 9,957.00	F. o. b. destination; shipping point, Pittsfield, Mass.	Do.
				do	do	[8] 18.60	do	Do.
879	All-American Canal, Calif.	1939 Oct. 18	Placing clay blanket on bottom and side slopes of All-American Canal, station 245+00 to station 1029+48.	J. W. and E. M. Breedlove Excavating Co.[9]	Alhambra, Calif.	93,040.00		Jan. 13
B-38,083-A	Columbia Basin, Wash. Central Valley Calif.	Dec. 29	Air compressors [6]	Ingersoll-Rand Co.	Denver, Colo.	[10] 6,975.00	F. o. b. Odair, Wash.; shipping point, Painted Post, N. Y.	Feb. 1
				do	do	[1] 6,975.00	F. o. b. Coram, Calif; shipping point, Painted Post, N. Y.	Do.
			Air compressors [3]	Pennsylvania Pump & Compressor Co.	Easton, Pa.	[13] 3,005.72 [11] 3,100.50		Jan. 31 Do.
889	Parker Dam Power, Ariz.-Calif.	1940 Jan. 8	270-ton overhead traveling crane for Parker power plant.	Cleveland Crane and Engineering Co.	Wickliffe, Ohio	68,000.00		(12)
48,566-A	Central Valley, Calif.	1939 Dec. 18	2,040,000 lin. feet of 1-inch o. d. black steel pipe or tubing.	National Electric Products Corporation.	Pittsburgh, Pa.	[13] 105,127.00	F. o. b. Friant; shipping point, Economy, Pa.; discount 5 percent.	Feb. 7
1313-D	do	Dec. 29	Fabricated pipe, fittings, valves, and appurtenances for bypass and air-inlet piping for the main-unit penstocks at Shasta Dam.	Willamette Iron and Steel Corporation.	Portland, Oreg.	[14] 24,937.00		[13] Feb. 12
				Geo. B. Limbert & Co.	Chicago, Ill.	[15] 3,354.00	F. o. b. Coram	Feb. 1
				Consolidated Supply Co.	Portland, Oreg.	[16] 5,350.00	F. o. b. Coram; discount 2 percent.	Feb. 2
				Merco Nordstrom Valve Co.	Oakland, Calif.	[17] 8,461.25	do	Feb. 3
885	do	1940 Jan. 16	Superstructure for Pit River bridge, Southern Pacific R. R. and U. S. Highway No. 99 relocation.	American Bridge Co.	Pittsburgh, Pa.	2,588,354.00	Material f. o. b., Gary, Ind.	Feb. 9
888	Parker Dam Power, Ariz.-Calif.	Jan. 8	Three 30,000-kilovolt-ampere generators for Parker power plant.	Westinghouse Electric and Manufacturing Co.	Denver, Colo.	1,088,330.00	F. o. b. E. Pittsburgh, Pa.	Do.
891	Colorado River, Tex.	Jan. 18	Trash racks for outlet works at Marshall Ford Dam.	Stupp Bros. Bridge & Iron Co.	St. Louis, Mo.	110,990.00		Do.
840	Colorado-Big Thompson, Colo.	1939 Sept. 21	Construction of Continental Divide tunnel.	(12)				Feb. 15
1323-D	Tucumcari, N. Mex.	1940 Jan. 23	47,000 barrels of modified portland cement in cloth sacks.	Southwestern Portland Cement Co.	El Paso, Tex.	89,300.00	Discount and sack allowance $0.50 per barrel.	Feb. 13
1325-D	Pine River, Colo.	Feb. 8	2 5- by 5-foot high-pressure gate assemblies.	Joshua Hendy Iron Works	San Francisco, Calif.	21,490.00	F. o. b. Sunnyvale, Calif.	Feb. 16
44,433-A	Parker Dam Power, Ariz.-Calif.	1939 Dec. 28	Concrete pumping machine and auxiliary equipment.	(12)				
884	Yakima-Roza, Wash.	1940 Jan. 26	Earthwork, canal lining and structures, stations 714+85 to 724, Yakima Ridge Canal; Wasteway No. 2, stations 0 to 57; and Yakima River Dike.	J. A. Terteling & Sons.	Boise, Idaho	98,870.00		Feb. 23
1324-D	Parker Dam Power, Ariz.-Calif.	Feb. 1	Absorptive form lining (240,000 square feet).	Dent & Russell, Inc.	Portland, Oreg.	8,400.00	F. o. b. Earp, Calif.; discount 2 percent.	Feb. 20
1326-D	Deschutes, Oreg.	Feb. 12	2 90-inch tube valves for Wickiup outlet works.	Joshua Hendy Iron Works	San Francisco, Calif.	26,249.00	F. o. b. Sunnyvale, Calif.	Feb. 21
48,583-B-1	Central Valley, Calif.	Feb. 9	8,000 barrels of standard portland cement in cloth sacks.	Monolith Portland Cement Co.	Los Angeles, Calif.	12,560.00	Sack allowance $0.40 per barrel.	Feb. 21
B-38,140-A	Columbia Basin, Wash.	Feb. 19	Steel reinforcement bars (2,100,000 pounds).	Bethlehem Steel Co.	San Francisco, Calif.	48,300.00	F. o. b. Odair, Wash.; discount ¼ percent on $0.47 less per hundredweight.	Feb. 28
44,452-A	Parker Dam Power, Ariz.-Calif.	Feb. 12	Steel reinforcement bars (1,700,000 pounds).	Columbia Steel Co.	do	37,090.00	F. o. b. Earp, Calif.; discount ¼ percent on $0.28 less per hundredweight; shipping point, Torrance, Calif.	Feb. 29

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[1] Schedule 4.
[2] Schedules 5 and 12.
[3] Schedule 6.
[4] Schedule 7.
[5] Schedule 8; no award.
[6] Schedule 9.
[7] Schedule 10.
[8] Schedule 11.
[9] Third low bidder.
[10] Schedule 3.
[11] Schedule 2.
[12] All bids rejected.
[13] Schedule 1.
[14] Item 1.
[15] Item 2.
[16] Item 3.
[17] Item 4.

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Modern Stockyards for Yakima

PLANS for the beginning of construction of modern stockyards at Yakima, representing an investment of $110,000, have been announced. Daily auctions will be conducted for the sale of cattle, hogs, sheep, horses, and poultry. The new stockyards are expected to assist valley growers in obtaining more convenient and direct marketing facilities.

Transformer Transportation Troubles

By E. P. BRYANT, *Chief Operator, Bureau of Power and Light, Boulder Power Plant*

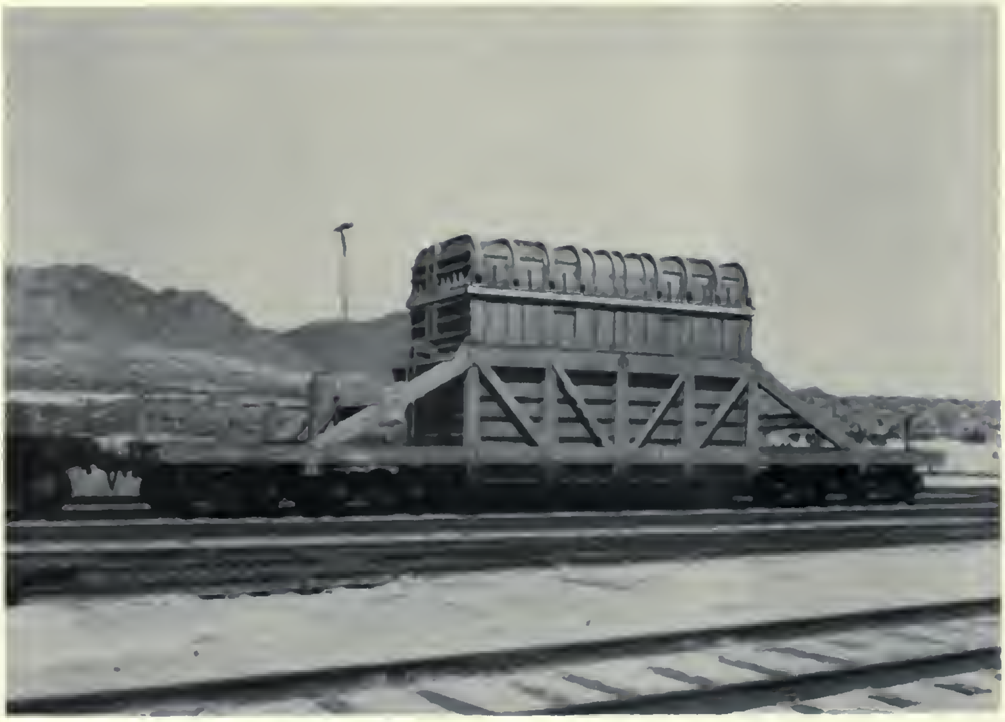
ON the morning of September 19, a small group of men gathered around a peculiar freight car in a large building of the General Electric Co. at Pittsfield, Mass. The car, a huge 16-wheel affair with a gross weight of 304,000 pounds, contained the core and coils of a 55,000-kilovolt-ampere 287,500-volt transformer sealed in an air-tight chamber filled with nitrogen gas. This transformer was scheduled for delivery to the Boulder power plant, where it would join others of its kind already furnishing power to the city of Los Angeles transmission system.

One of the men in this group, W. J. Leavy, a tracer for the General Electric Co., was to follow that car on its long trip across the continent. For almost 3 weeks he would watch it night and day to see that it had the best of care and reached its destination on time. He would check the gas pressure at every opportunity, and make the necessary adjustments for changes in temperature. He would observe the condition of the car, and have it shunted to a siding if there was any indication of trouble which might endanger it or its contents. He would contact the various train crews who would handle the car, and see that they made every effort to protect it from shock or jar. This would mean that it should be handled carefully during switching and placed close to the locomotive for runs on the main line.

At last all the preparations were completed and the car now listed in the train orders as GEX 15001 was taken in tow by a switch engine and hauled to the Pittsfield freight yard of the Boston & Albany Railroad. At this point it was made up in a train bound for Albany, N. Y. Because of excessive size this ugly duckling was not a welcome addition to the train. In the double-track sections on this line, it would not pass standard freight cars on the opposite track, in curves, or hopper-type coal cars on the straightaways. This made it necessary for the dispatchers to prepare special train schedules for each division. Also, a neat little metal box bolted to the deck of GEX 15001, gave the engine crew a severe headache. This device called a "shock recorder," draws a graph of car vibration during the entire trip, and faithfully records any careless handling of brakes or throttle, giving the date and time. For this reason it is not popular with the train crews who call it a "snake." Finally, arriving in Albany, the car was put on a siding and turned over to the New York Central Railroad.

After a thorough inspection at Albany, the car was released by the tracer for a trip over the main line of the New York Central Railroad, to Buffalo, N. Y. On this portion of its trip, the car passed through Syracuse and Rochester. In the first of these cities the tracks are in the main business section at street level, and the trains join the regular traffic and move at reduced speed. At Buffalo, the transformer car was placed on a siding in the freight yard for inspection and service. A few hours later it was again on its way, and soon arrived in the freight yards on the American side of the big steel suspension bridge across the Niagara River.

General Electric transformer car



Detour Through Canada

As the car was now about to enter Canada, it was necessary to comply with certain customs regulations. When they were taken care of, GEX 15001 was added to a Canadian National Railways train and started out for Windsor, Ontario. After passing through the cities of Welland and St. Thomas, it reached the city of Windsor, just across the river from Detroit, Mich. This brief detour through Canada was made because of limited clearance, and traffic conditions on the older American systems in this area. At Windsor the train was split, with American-bound cars scheduled for delivery by way of the tunnel under the Detroit River. However, because of its excess size, GEX 15001 could not get through the tunnel and was therefore put on a siding to await a car ferry which is now seldom used.

Eventually it arrived back in the United States at Detroit, and resumed its journey toward Chicago. Because of innumerable low bridges, viaducts, high voltage catenaries, and other obstacles in the vicinity of Chicago, our oversized car carefully avoided that city. It took a long detour down through southern Indiana and Illinois, over the systems of the Wabash, the Toledo, Peoria & Western, the Minneapolis, St. Paul & St. Louis, and the Chicago, Milwaukee, St. Paul & Pacific railroads.

At each junction point the car was held for service and inspection. It was not released until the tracer and the railroad crews were satisfied that it was in good order. Thus far the trip had been rather slow, with short runs and frequent stops. This made it easy for the tracer to keep up with his charge, but required many inspections, most of which were made at night. By careful study of passenger-train schedules he had managed to travel with a certain degree of comfort, and still arrive at each division point in ample time to do all necessary work.

Faster Travel Beyond Omaha

Arriving at Omaha, Nebr., the transformer car was made up in a west-bound fast freight on the Union Pacific Railroad. From this point on GEX 15001 really started to travel. On the long level stretches through Nebraska and Wyoming its speed often reached 80 miles per hour. This made it difficult to catch, as the passenger trains were not as frequent as in the East. For this reason, the tracer often rode in the caboose, so as to be on hand at the proper time for inspections. Although the division points were now quite far apart, the tracers work was not getting any easier. The colder weather at the higher elevations made it necessary to increase the pressure in the gas chamber, also the heavy duty car journals needed close watching because of the high speed.

All went well until the car approached the Utah border. Here a short tunnel near Evanston, Wyo., blocked further passage toward the West. A long detour to the north through McCannon, Idaho, made it possible to get around this obstacle and finally reach Ogden, Utah. Just before making this detour the car crossed the Green River, one of the main tributaries of the Colorado. It is quite probable that the water under the bridge at that time would ultimately pass through the Boulder turbines, and some of its energy would be passed on to Los Angeles through this new transformer.

By this time GEX 15001 was not a pretty thing to look at. Because of its peculiar shape and many braces, it was piled high with black dust and cinders from the many coal-burning locomotives it had followed. Now the worst was over, because nothing but oil would be used west of Ogden.

In southern Utah, the car encountered a steady cold rain, which turned to snow as the Nevada State line was reached, soon the top was covered with a heavy blanket of snow and the temperature of the gas chamber dropped below the freezing point. This made it necessary to draw heavily upon the reserve supply of nitrogen. In a few hours the storm passed away, and the rising temperatures gave assurance of an ample supply of gas for the rest of the trip.

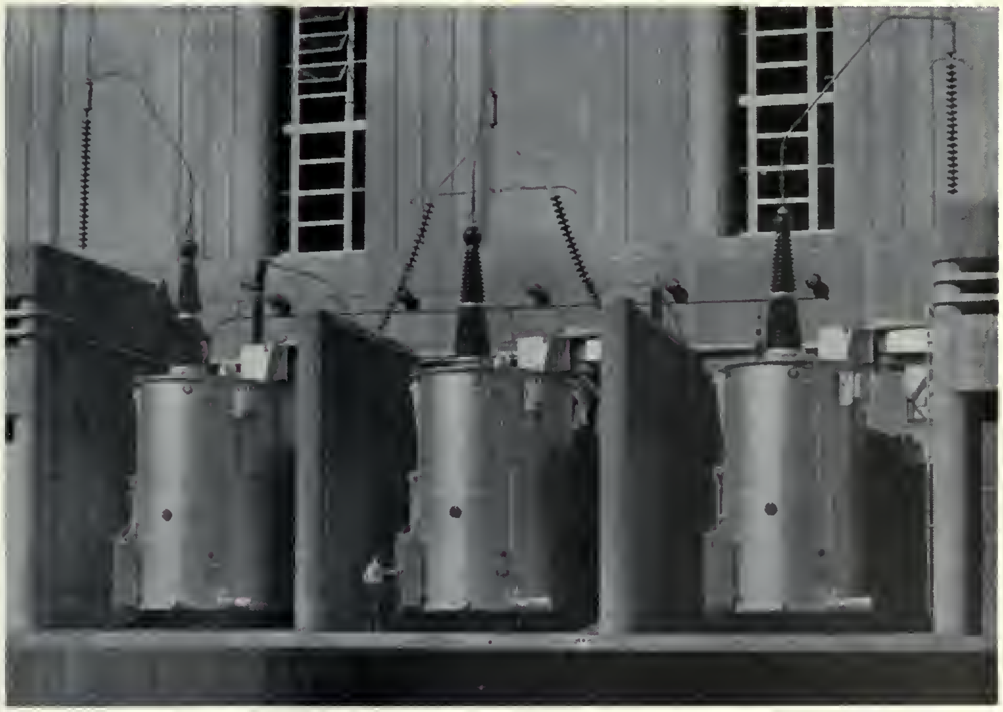
Reaches Boulder Dam in Good Shape

Arriving at the junction point in Las Vegas, Nev., too late to make connection with the regular train to Boulder City, it was necessary for the tracer to arrange for a special locomotive or sacrifice 36 hours of valuable time. After an exchange of telegrams, a special locomotive was secured and GEX 15001 arrived at Boulder City a few hours later. Here it was taken over by a Government locomotive and hauled over the Reclamation Bureau Railroad to the unloading station near Boulder Dam. It arrived at its destination on October 5 after covering about 3,700 miles in 17 days. This included portions of 9 railroad systems in 12 of the States in our country, and one province of Canada. The completion of this difficult job on schedule time is indeed a tribute to the efficiency of our railroad systems, and the men who keep them going.

Examination of the transformer revealed that it was in perfect condition and ready for many years of useful service. Although tired and weary from his long trip, Mr. Leavy brightened considerably as he turned

Eighty-ton core and coil for 55,000-kilovolt-ampere single-phase transformer after being removed from transformer car tank

Bank of 55,000-kilovolt-ampere single-phase transformer for units N–1 and N–2



his charge over to the local representative of the General Electric Co. Before starting back to Pittsfield he took time out to tell us something about his work.

Previous Trips by Mr. Leavy

Starting in 1926, he has delivered transformers to practically all parts of Canada, the United States, and Mexico. Some of his early trips were particularly interesting. Before the advent of gas filled steel tank cars like GEX 15000 and its mate GEX 15001 it was customary to ship large transformers on special flat cars. A wooden structure covered with tar paper was erected over the transformer to protect it from the weather, and a coal-fired boiler was installed to furnish hot water to keep it warm and dry. The tracer rode on the car for the entire trip and kept the fire going in the boiler. During odd moments he cooked his meals, washed his clothes, and obtained what sleep he could in a hammock. The peak of perfection on these early trips was usually reached on cold rainy nights when the transformer car was preceded by four or five cars of pigs.

Modern trips are not without some excitement. To find a special transformer car in a large congested freight yard, in the wee small hours of the morning, is not always easy. Fast moving switch engines, hoboes, and railroad policemen are certain hazards that are difficult to anticipate. Wrecks, wash-outs, and shifting loads occasionally present problems that call for quick action on the job. A recent trip from Pittsfield to Seattle in 10 days established a record which still stands. In spite of hot bearings and various other troubles, three large transformers were delivered on schedule, to meet an emergency condition. Often separated by many miles, the cars and their loads were constantly watched over by the tracer and all arrived in good order.

To those of us who spend our lives in more or less fixed locations the work of a tracer appears fascinating. To travel all over the country at the expense of someone else, would indeed be a pleasure. However, the hazards and hardships would probably be too much for most of us. We wish Mr. Leavy continued success in his peculiar occupation, and look forward to future visits.

Reclamation Archives

(*Continued from page 82*)

frugality, would be building for our Nation's future on the solid rock. The country is the Nation's hope. Rural life is conducive to purity of character. I think the blending of our ideas, the exaltation of agriculture, the application of science to farming, the encouragement of migration to the country instead of to the city, the transforming of waste places into smiling plenty, will do more for the Nation's prosperity, development, and happiness than any suggestions offered to the public. I do not know that the people are ready to cooperate to this end, but I do believe true wisdom invites such methods.'

"The Government has in southern Arizona an interesting irrigation and Indian problem combined. It appears that the Pimas, Maricopas and Paliajoes were agricultural Indians, who had supported themselves from time immemorial by irrigating their lands by water taken from the Gila River. In early times these Indians were of great service to the whites in protecting them against the Apaches; but as the population increased the whites began to take up the water of the Gila River, until they finally succeeded in getting control of it all, leaving the poor Indian literally high and dry. He can no longer keep up his farming; and, although the Government is spending large sums on his education, he is left without substantial means of support. Someone has aptly said that the coming of the whites has changed these Indians from a condition of self-supporting savagery to that of dependence on Government rations and petty thieving under civilization. The practical problem is to get back the water that used to flow in that river. This can probably be accomplished by building a good-sized dam at a point above the reservation, and there holding the stream at flood. Congress has appropriated $20,000 for an investigation of the question, and preliminary examinations have been made. It probably will cost $2,000,000 to construct the dam, which would have to be done by the Government or some community effort. But this is something which must be undertaken if we are ever to utilize the beautiful lands of southern Arizona."

Since this statement by Mr. Newell, his vision expressed as above, almost 42 years ago, has been more than realized.

Under the Federal Reclamation policy inaugurated in 1902, 156 storage and diversion dams have been built. Water has been brought to these fertile valleys; homes and communities have been established; and popular demand has set up highways and railroad systems to serve them, of which the West might justly be proud.

Porter J. Preston, New President Colorado Society of Engineers

PORTER J. PRESTON, supervising engineer of the Colorado-Big Thompson project, was elected president of the Colorado Society of Engineers on January 20 at the second and closing day of its twelfth annual convention, succeeding Dr. Fred C. Carstarphen, prominent engineer in the mining world. The Colorado Society of Engineers, founded on helpfulness, built on service, and dedicated to conservative progress, is the largest State engineering organization in the Nation, and is successfully directing a definite program of improving the economic status of engineers and creating among engineers a more active interest in matters of policy.

The society has progressed steadily in membership, beginning with an enrollment of 10 in 1916, and increasing to an enrollment of nearly 1,400 members.

One of the outstanding achievements of the society which has won Nation-wide recognition, is the maintaining of a free employment service for engineers. During a 10-year period, the average saving to engineers securing employment through the society (based on fees charged by commercial agencies) has amounted to nearly $13,000 a year.

National Rivers and Harbors Congress Annual Convention

THE thirty-fifth annual convention of the National Rivers and Harbors Congress was held at the Mayflower Hotel in Washington, D. C., March 14–15. President Roosevelt made the following statement relating to this group:

"It seems to me that the great strides we have made during the past 6 years in the effective development of our waterways and the solution of flood-control problems are in no small measure due to the comprehensive and integrated program developed and forwarded by the National Rivers and Harbors Congress. Proper deliberation that leads to sponsorship of the worthy projects and omission of the unsound can only result in lasting economy to the people and permanent benefits to the welfare of the Nation.

"It is gratifying at a time when world events force us to attend more closely our system of national defense to know that your organization has through the years of its existence advocated a rational development of our waterways, an element of our communication system essential to the safety and defense of the Nation.

"I congratulate you on all you have achieved in the past and urge that you continue to approach your task with vision and foresight."

Commissioner Page addressed the group on the subject "Cooperation, the Corps of Engineers and the Bureau of Reclamation." His address will appear in the April issue, together with any resolutions passed by the Congress pertaining to Federal reclamation.

The projects committee met two days preceding the conference for consideration of individual projects and to advise and assist the sponsors of the projects in preparing their data and presenting their projects to the convention. The Bureau supplied a map showing the reclamation projects for use at the projects committee hearings.

The Bureau installed a pictorial exhibit depicting its work.

Kings River Project Declared Feasible

THE Kings River project, California, was declared feasible and its construction under the reclamation law was recommended by Secretary of the Interior Harold L. Ickes in his report on the project transmitted to Congress on February 10.

The irrigation, flood control, and power development would cost an estimated $22,300,000, of which $9,950,000 would be allocated to irrigation to be repaid by water users on 800,000 acres of developed land near Fresno, now in need of supplemental irrigation water; $9,950,000 would be allocated to flood control under a finding agreed to by the Corps of Engineers; and $2,600,000 would be allocated to power for repayment in 40 years with interest at 3½ percent from power sales. A connection with the Central Valley project system would enable a desirable interchange of power.

The report contemplates construction of Pine Flat Dam, a concrete structure 413 feet high, which would impound 1,000,000 acre-feet of water; a power plant of a capacity of 15,000 kilowatts and transmission lines; and miscellaneous minor works. The report in addition recommends for future consideration, but not for inclusion in the initial unit of the project, a large power development on the North Fork of the Kings River.

In the first report submitted under section 9 of the Reclamation Project Act of 1939, Commissioner John C. Page, Bureau of Reclamation, said:

"In this project irrigation and power combined exceed flood control both as to costs and benefits. Since navigation is not involved, and the flood damage to be eliminated is almost wholly local, as also are the anticipated flood-control benefits, the project is more one of irrigation than for flood control. * * *

"* * * Water releases (from the reservoir) must conform to vested irrigation rights.

"In the circumstances, I believe that the project, if and when undertaken, should be constructed and operated by the Bureau of Reclamation."

Mr. Page said that the benefits derived from the project would far exceed the cost.

Calculations in the report, completed after more than 2 years of intensive field study, showed annual benefits resulting from the three lines of services to which allocations were made, far exceeding the annual costs. Annual flood-control benefits would be $1,185,000 as against an annual cost of $465,000, contemplating amortization of the cost of flood control in 40 years with interest at 3½ percent. Irrigation benefits would be $1,255,000 each year, against a cost of $263,750, which would be paid by water users and which would repay the irrigation allocation as required by reclamation law. While annual costs for Kings River power would be but $174,000 for generation at the Government plant and for local distribution, the benefits each year would be $677,000 arising from use of project power and of power from the Central Valley project system. The report contemplates use of the initial project power by water users for pumping, and the benefits largely are savings in pumping costs.

Secretary Ickes, in his finding said, "The proposed allocation of costs is proper and equals the estimated cost of the project. The repayment of reimbursable costs can be anticipated with assurance. I find the project desirable, economically and engineeringly feasible, and authorized for construction under the provisions of section 9 of the Reclamation Act of 1939. I therefore recommend its construction thereunder, if and when funds are made available."

Death of A. H. Shellenberger

ALDUS H. SHELLENBERGER, former fiscal agent of the Bureau of Reclamation, died February 25, 1940, at Walter Reed Hospital, Washington, D. C.

Born in Lancaster County, Pa., April 30, 1877, Mr. Shellenberger taught school for a number of years in Millersville, Pa. He enlisted in the military service during the Spanish-American War, and in 1902–3, under the Navy Department at naval station, San Juan, Porto Rico, he was in charge of requisitions and supplies and general bookkeeping, following which he spent 10 years in the employ of the Reclamation Service in vouchering accounts, their examination, audit, and other bookkeeping matters. During this time he acted in an advisory and supervisory capacity of a number of field offices. In 1918 he accepted a transfer to the Medical Department at Large of the War Department, and later was transferred to the General Accounting Office, with which he was connected until the time of his death.

Surviving Mr. Shellenberger are his wife, and a daughter, Mrs. Marguerite A. Paul.

Parker Dam Power

GENERATORS for initial installation of power equipment in Parker Dam power plant are on order. The Westinghouse Electric & Manufacturing Co. of Denver submitted its bid of $1,088,330 for furnishing three 30,000-kilovolt-ampere generators. Three bids for the generators were received and opened at the Denver office of the Bureau of Reclamation on January 8.

The generators are for units 1, 2, and 3, which comprise the initial installation. Three 40,000-horsepower turbines, and three governors for these units have been ordered under another contract.

The Paker Dam power plant is being constructed to house ultimately four main generating units, each with a capacity of 30,000 kilowatts.

Parker Dam, 155 miles downstream from Boulder Dam on the Colorado River, was built by the Bureau of Reclamation for the Metropolitan Water District of Southern California, to divert water into the Colorado River Aqueduct. Although constructed primarily for the purpose of supplying Los Angeles, and 12 other cities in southern California with water, Parker Dam will serve also to generate electric energy for the District, and for irrigation pumping requirements.

Under the present award, the contractor is required to deliver the first generator within 360 days, the second within 420 days, and the third within 480 days after date of receipt of notice of award of contract. The Bureau of Reclamation will install the machinery.

MRS. SARAH GRIGG

1874–1940

MRS. SARAH GRIGG, clerk in the Accounts Division of the Bureau of Reclamation, entered George Washington University Hospital on January 2, 1940, to undergo treatment for a serious ailment from which she had suffered several months, although she had been almost continuously at her desk in the office until Christmas week. Her death, though expected, was not deemed imminent.

Mrs. Grigg's service in the Bureau of Reclamation dated from April 19, 1905, hence she had accrued a service in the Government of nearly 35 years.

Surviving Mrs. Grigg are her son, Joseph Blake Grigg, and a sister, Mrs. Albert P. Myers, both of Washington, D. C.

Boulder Visitors

DURING the month of January, Boulder Dam recreational area was visited by 28,468 persons, Boat Dock and Hemenway Wash by 4,535, and Boulder Dam power plant by 12,430.

Interior Department Motion Picture Service

THE Department of the Interior has available for free distribution motion-picture films pertaining to the activities of its various bureaus. Primarily a Conservation Department, this branch of the Government is distributing these films for the purpose of informing the public of the conservation policies laid down by Congress, and the service performed by the Department, under these laws, in the National and State parks, National monuments, and historical areas, the reclamation projects, Indian reservations, and in the conservation of the natural resources of the Nation in such areas as are under the Department's jurisdiction.

Lists of films, including a statement regarding the terms of loans, and other instructions to borrowers, may be obtained by addressing the Photographic Section, Division of Information, Department of the Interior, Washington, D. C.

New Map Available

A MAP of portions of Nevada and California showing irrigation and hydroelectric development in the Truckee, Carson, Humboldt, and Walker River Basins has just been issued by the Bureau of Reclamation and may be obtained upon application to the Bureau, payment to be made in advance by check or money order drawn to the Bureau of Reclamation. *Postage stamps are not acceptable.*

Map No. 38-408 (1939). Colored; size, 18 by 24 inches. Price, 15 cents each.

Map No. 38-408A (1939). Colored; size, 22 by 30 inches. Price, 25 cents each.

Klamath Building Activity

BUILDING permit figures released by the city of Klamath Falls, Oreg., headquarters of the Kalmath project, show that permits were issued during 1939 for $584,985, as compared with $443,185 for the previous year, representing an increase of $141,800.

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CUT ALONG THIS LINE

(Date)..............................

COMMISSIONER,
Bureau of Reclamation,
Washington, D. C.

SIR: I am enclosing my check [1] (or money order) for $1.00 to pay for a year's subscription to THE RECLAMATION ERA.

Very truly yours,

March 1940.

(Name)..

(Address)...

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[1] Do not send stamps.

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Projects under construction or operated in whole or in part by the Bureau of Reclamation

Project	Office	Official in charge		Chief clerk	District counsel	
		Name	Title		Name	Address
All-American Canal	Yuma, Ariz.	Leo J. Foster	Construction engineer	J. C. Thrailkill	R. J. Coffey	Los Angeles, Calif.
Belle Fourche	Newell, S. Dak	F. C. Youoghlutt	Superintendent	J. P. Sieheneicher	W. J. Burke	Billings, Mont.
Boise	Boise, Idaho	R. J. Newell	Construction engineer	Robert B. Smith	B. E. Stoutemyer	Portland, Oreg.
Boulder Canyon [1]	Boulder City, Nev	Irving C. Harris	Director of power	Gail H. Baird	R. J. Coffey	Los Angeles, Calif.
Buffalo Rapids	Glendive, Mont	Paul A. Jones	Construction engineer	Edwin M. Bean	W. J. Burke	Billings, Mont.
Buford-Trenten	Willisten, N. Dak	Parley R. Neeley	Resident engineer	Robert L. Newman	W. J. Burke	Billings, Mont.
Carlshad	Carlsbad, N. Mex	L. E. Foster	Superintendent	E. W. Shepard	H. J. S. Devries	El Paso, Tex.
Central Valley	Sacramento, Calif	W. R. Young	Supervising engineer	E. R. Mills	R. J. Coffey	Los Angeles, Calif.
Shasta Dam	Redding, Calif	Ralph Lowry	Construction engineer		R. J. Coffey	Los Angeles, Calif.
Friant division	Friant, Calif	R. B. Williams	Construction engineer		R. J. Coffey	Los Angeles, Calif.
Delta division	Antioch, Calif	Oscar G. Boden	Construction engineer		R. J. Coffey	Los Angeles, Calif.
Colorado-Big Thompson	Estes Park, Colo	Porter J. Preston	Supervising engineer	C. M. Voyen	J. R. Alexander	Salt Lake City, Utah.
Colorado River	Austin, Tex	Ernest A. Moritz	Construction engineer	William F. Sha	H. J. S. Devries	El Paso, Tex.
Columbia Basin	Coulee Dam, Wash	F. A. Banks	Supervising engineer	C. B. Funk	B. E. Stoutemyer	Portland, Oreg.
Deschutes	Bend, Oreg	D. S. Stuver	Construction engineer	Nohle O. Anderson	B. E. Stoutemyer	Portland, Oreg.
Gila	Yuma, Ariz	Leo J. Foster	Construction engineer	J. C. Thrailkill	R. J. Coffey	Los Angeles, Calif.
Grand Valley	Grand Junction, Colo	W. J. Chiesman	Superintendent	Emil T. Ficenec	J. R. Alexander	Salt Lake City, Utah.
Humboldt	Reno, Nev	Floyd M. Spencer	Acting Construction engineer		J. R. Alexander	Salt Lake City, Utah.
Keodrick	Gasper, Wyo	Irvin J. Matthewa	Construction engineer [2]	George W. Lyle	W. J. Burke	Billings, Moot.
Klamath	Klamath Falls, Oreg	B. E. Hayden	Superintendent	W. I. Tingley	B. E. Stoutemyer	Portland, Oreg.
Milk River	Malta, Mont	H. H. Johnson	Superioteodent	E. E. Chabot	W. J. Burke	Billings, Mont.
Fresno Dam	Havre, Mont		Construction engineer	E. E. Chabot	W. J. Burke	Billings, Mont.
Minidoka	Burley, Idaho	Stanley R. Marean	Superinteodent	G. C. Patterson	B. E. Stoutemyer	Portland, Oreg.
Minidoka Power Plant	Burley, Idaho	Samuel A. McWilliama	Resident engineer		B. E. Steutemyer	Portland, Oreg.
Moon Lake	Provo, Utah	E. O. Larson	Construction engineer	Francis J. Farrell	J. R. Alexander	Salt Lake City, Utah.
North Platte	Guernsey, Wyo	C. F. Gleason	Superintendent of power	A. T. Stimpfig	W. J. Burke	Billings, Mont.
Ogdeo River	Provo, Utah	E. O. Larson	Construction engineer	Francis J. Farrell	J. R. Alexander	Salt Lake City, Utah.
Orland	Orland, Calif	D. L. Garmody	Superiotendent	W. D. Funk	R. J. Coffey	Los Angeles, Calif.
Owyhee	Boise, Idaho	R. J. Newell	Construction engioeer	Rohert B. Smith	B. E. Stoutemyer	Portland, Oreg.
Parker Dam Power	Parker Dam, Calif	E. C. Koppen	Construction engineer	George B. Snow	R. J. Coffey	Los Angeles, Calif.
Pine River	Vallecito, Colo	Gharles A. Burns	Construction engineer	Frank E. Gawn	J. R. Alexander	Salt Lake City, Utah.
Rapid Valley	Rapid City, S. D	Horace V. Huhbell	Constructioo engineer		W. J. Burke	Billings, Mont.
Provo River	Provo, Utah	E. O. Larson	Construction engineer	Francis J. Farrell	J. R. Alexander	Salt Lake City, Utah.
Rio Grande	El Paso, Tex	L. R. Fiock	Superintendent	H. H. Berryhill	H. J. S. Devries	El Paso, Tex.
Elephant Butte Power Plant	Elephant Butte, N. Mex		Resident engioeer	H. H. Berryhill	H. J. S. Devries	El Paso, Tex.
Riverton	Riverton, Wyo	H. D. Comstock	Superintendent	G. B. Wentzel	W. J. Burke	Billings, Mont.
Saopete	Provo, Utah	E. O. Larson	Construction engineer	Francis J. Farrell	J. R. Alexander	Salt Lake City, Utah.
Shoshone	Powell, Wyo	L. J. Windle	Superintendent [2]	L. J. Windle [2]	W. J. Burke	Billings, Mont.
Heart Mountain division	Cody, Wyo	Walter F. Kemp	Construction engineer	L. J. Windle [2]	W. J. Burke	Billings, Mont.
Sun River	Fairfield, Mont	A. W. Walker	Superintendent		W. J. Burke	Billings, Mont.
Truckee River Storage	Reno, Nev	Floyd M. Spencer	Acting Construction engineer		J. R. Alexander	Salt Lake City, Utah.
Tucumcari	Tucumcari, N. Mex	Harold W. Mutch	Engineer	Charles L. Harris	H. J. S. Devries	El Paso, Tex.
Umstilla (McKay Dam)	Pendleton, Oreg	C. L. Tice	Reservoir superintendent		B. E. Stoutemyer	Portland, Oreg.
Uocompahgre: Repairs to canals	Montrose, Colo	Denton J. Paul	Engineer	Ewalt P. Anderson	J. R. Alexander	Salt Lake City, Utah.
Upper Snake River Storage [3]	Ashton, Idaho	I. Dooald Jerman	Construction engineer [2]	Emmanuel V. Hillius	B. E. Stoutemyer	Portland, Oreg.
Vale	Vale, Oreg	C. C. Ketehum	Superintendeot		B. E. Stoutemyer	Portland, Oreg.
Yakima	Yakima, Wash	J. S. Moore	Superintendent	Conrad J. Ralston	B. E. Stoutemyer	Portland, Oreg.
Roza division	Yakima, Wash	Charles E. Crownover	Construction engineer	Alex S. Harker	B. E. Stoutemyer	Portland, Oreg.
Yuma	Yuma, Ariz	C. B. Elliott	Superintendeot	Jacob T. Davenport	R. J. Goffey	Los Angeles, Calif.

[1] Boulder Dam and Power Plant.

[2] Acting.

[3] Island Park and Grassy Lake Dams.

Projects or divisions of projects of Bureau of Reclamation operated by water users

Project	Organization	Office	Operating official		Secretary	
			Name	Title	Name	Address
Baker (Thief Valley division) [1]	Lower Powder River irrigation district	Baker, Oreg	A. J. Ritter	President	F. A. Phillips	Keating.
Bitter Root [4]	Bitter Root irrigation district	Hamilton, Mont	G. R. Walsh	Manager	Elsie H. Wagner	Hamilten.
Boise [1]	Board of Control	Boise, Idaho	Wm. H. Tuller	Project manager	L. P. Jensen	Boise.
Boise [1]	Black Canyon irrigation district	Notus, Idaho	W. H. Jordan	Superintendeot	L. M Watson	Caldwell.
Burnt River	Burnt River irrigation district	Huntington, Oreg	Edward Sullivan	President	Harold H. Hursh	Huntington.
Frenchtown	Frenchtown irrigation district	Frenchtown, Mont	Edward Donlan	President	Ralph P. Schaffer	Huson.
Graod Valley, Orchard Mesa [3]	Orchard Mesa irrigation district	Grand Junction, Colo	C. W. Tharp	Superintendent	C. J. McCormich	Grand Jctn.
Huntley [4]	Huntley irrigation district	Ballantine, Mont	E. E. Lewis	Manager	H. S. Elliott	Ballaotine.
Hyrum [2]	South Cache W. U. A.	Wellsville, Utah	B. L. Meodenhall	Superintendent	Harry C. Parker	Logan.
Klamath, Langell Valley [1]	Langell Valley irrigation district	Bonanza, Oreg	Chas. A. Revell	Manager	Chas. A. Revell	Bonanxa.
Klamath, Horsefly [1]	Horsefly irrigation district	Bonanxa, Oreg	Henry Schmor, Jr	President	Dorothy Eyers	Bonanza.
Lower Yellowstone [4]	Board of Control	Sidney, Mont	Axel Persson	Manager	Axel Persson	Sidney.
Milk River: Chinook division [4]	Alfalfa Valley irrigation district	Ghinook, Mont	A. L. Benten	President	R. H. Clarkson	Chinook.
	Fort Belknap irrigation district	Ghinook, Mont	H. B. Bonefright	President	L. V. Bogy	Chinook.
	Zurich irrigation district	Harlem, Mont	C. A. Watkins	President	H. M. Montgomery	Chinook.
	Harlem irrigation district	Harlem, Mont	Thos. M. Everett	President	Geo. H. Tout	Harlem.
	Paradise Valley irrigation district	Zurich, Mont	R. E. Musgrove	President	J. F. Sharples	Zurich.
Minidoka: Gravity [1]	Minidoka irrigation district	Rupert, Idaho	Frank A. Ballard	Manager	O. W. Paul	Rupert.
Pumping	Burley irrigation district	Burley, Idaho	Hugh L. Crawford	Manager	Frank O. Redfield	Burley.
Gooding [1]	Amer. Falls Reserv. Dist. No. 2	Gooding, Idaho	S. T. Baer	Manager	Ida M. Johnson	Gooding.
Newlands [3]	Truckee-Carson irrigation district	Fallon, Nev	W. H. Wallace	Manager	E. W. Emery	Fallon.
North Platte: Interstate division [4]	Pathfinder irrigation district	Mitchell, Nehr	T. W. Parry	Manager	Flora K. Schroeder	Mitchell.
Fort Laramie division [4]	Gering-Fort Laramie irrigation district	Gering, Nehr	W. O. Fleenor	Superintendent	C. O. Klingman	Gering.
Fort Laramie division [4]	Goshen irrigation district	Torrington, Wyo	Floyd M. Roush	Superintendent	Mary E. Harrach	Torrington.
Northport division [4]	Northport irrigation district	Northport, Nehr	Mark Iddings	Manager	Mabel J. Thompson	Bridgeport.
Ogden River	Ogden River W. U. A.	Ogden, Utah	David A. Scott	Superintendent	Wm. P. Stephens	Ogden.
Okanogan [1]	Okanogan irrigation district	Okanogan, Wash	Nelson D. Thorp	Manager	Nelson D. Thorp	Okanogan.
Salt Lake Basin (Echo Res.) [3]	Weher River Water Users' Assn	Ogden, Utah	D. D. Harris	Manager	D. D. Harris	Layton.
Salt River [2]	Salt River Valley W. U. A.	Phoenix, Aris	H. J. Lawson	Superintendent	F. C. Henshaw	Phoenix.
Shoshone: Garland division [4]	Shoshone irrigation district	Powell, Wyo	Paul Nelson	Acting irri. supt	Harry Barrows	Powell.
Frannie division [4]	Deaver irrigation district	Deaver, Wyo	Floyd Lucas	Manager	R. J. Schwendiman	Deaver.
Strawberry Valley	Strawherry Water Users' Assn	Payson, Utah	S. W. Grotegut	President	E. G. Breeze	Payson.
Sun River: Fort Shaw division [4]	Fort Shaw irrigation district	Fort Shaw, Mont	C. L. Bailey	Manager	C. L. Bailey	Fort Shaw.
Greenfields division [4]	Greenfields irrigation district	Fairfield, Mont	A. W. Walker	Manager	H. P. Wangen	Fairfield.
Umatilla, East division [1]	Hermiston irrigation district	Hermisten, Oreg	E. D. Martin	Manager	Enos D. Martin	Hermisten.
West division [1]	West Extension irrigation district	Irrigon, Oreg	A. C. Houghten	Manager	A. C. Houghton	Irrigon.
Uncompahgre [3]	Uncompahgre Valley W. U. A.	Montrose, Colo	Jesse R. Thompson	Manager	H. D. Galloway	Montrose.
Yakima, Kittitas division [1]	Kittitas reclamation district	Ellenshurg, Wash	G. G. Hughes	Acting manager	O. L. Sterling	Ellensburg.

[1] B. E. Stoutemyer, district counsel, Portland, Oreg.

[2] R. J. Coffey, district counsel, Los Angeles, Calif.

[3] J. R. Alexander, district counsel, Salt Lake City, Utah.

[4] W. J. Burke, district counsel, Billings, Mont.

Important investigations in progress

Project	Office	In charge of—	Title
Colorado River Basin, sec. 15 (Colo., Wyo., Utah, N. Mex.)	Denver, Colo	E. B. Dehler	Senior engineer.
Fort Peck Pumping (Mont., N. Dak.)	Denver, Colo	W. O. Sloan	Engineer.
Missouri River Pumping (N. Dak., S. Dak.)	Denver, Colo	W. G. Sloan	Engineer.
Yellowatene Basin (Mont.)	Helena, Mont	F. V. Munro	Engineer.
Big Horn Basin (Mont., Wyo.)	Denver, Colo	W. G. Sloan	Engineer.
Red River and North Canadian River (Okla.)	Denver, Colo	A. N. Thompson	Engineer.
Arkansas Valley (Colo., Kans.)	Denver, Colo	A. N. Thompson	Engineer.
Challis, Salmon River (Idaho)	Salmon City, Idaho	O. L. Kime	Associate engineer.
Rohert Lee (Tex.)	Austin, Tex	E. A. Morita	Construction engineer.
Duchesne-Sevler (Utah)	Salt Lake City, Utah	E. G. Nielsen	Engineer.
Williams, Hassayampa, Little Colorado (Ariz.)	Phoenix, Aris	M. E. Bunger	Engineer.

Issued monthly by the Bureau of Reclamation, Department of the Interior, as approved by the Director of the Budget. SALLIE A. B. COE, *Editor*.

SCENES IN RECLAMATION TERRITORY

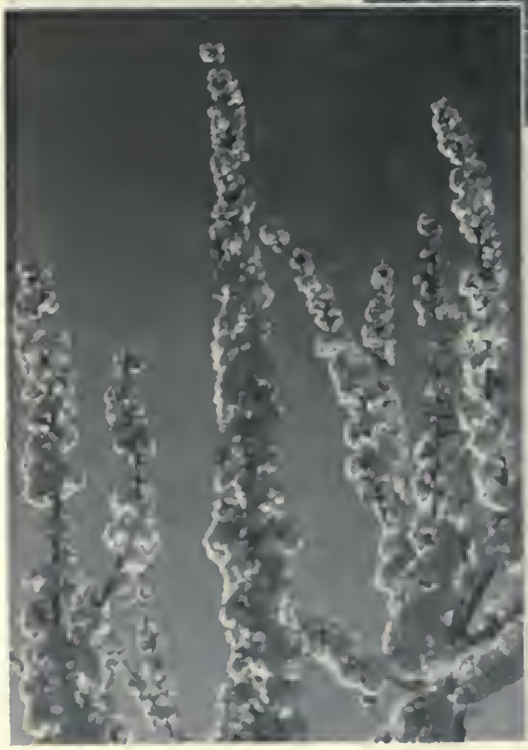
TRANSMISSION LINE at Green Mountain Damsite, Colorado.

Right
YOUNG SHOOTS are wearing white Easter bonnets this spring in the Coachella Valley, California

TUNNEL CURVE at Green Mountain Damsite, Colorado

SALMON from the Columbia River jump to their new home in a safer stream. Massive Grand Coulee Dam made necessary this "resettlement" program.

MARCH PROMISE



A "Thermit" pressure weld on a 131-lb rail joint of the relocated railroad around Shasta reservoir [illegible] California

THIRTY-TWO TONS AT A BITE this shovel is digging the 134-mile Coachella branch of the All-American Canal California

SCENES IN
RECLAMATION TERRITORY

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THE RECLAMATION ERA

APRIL 1940

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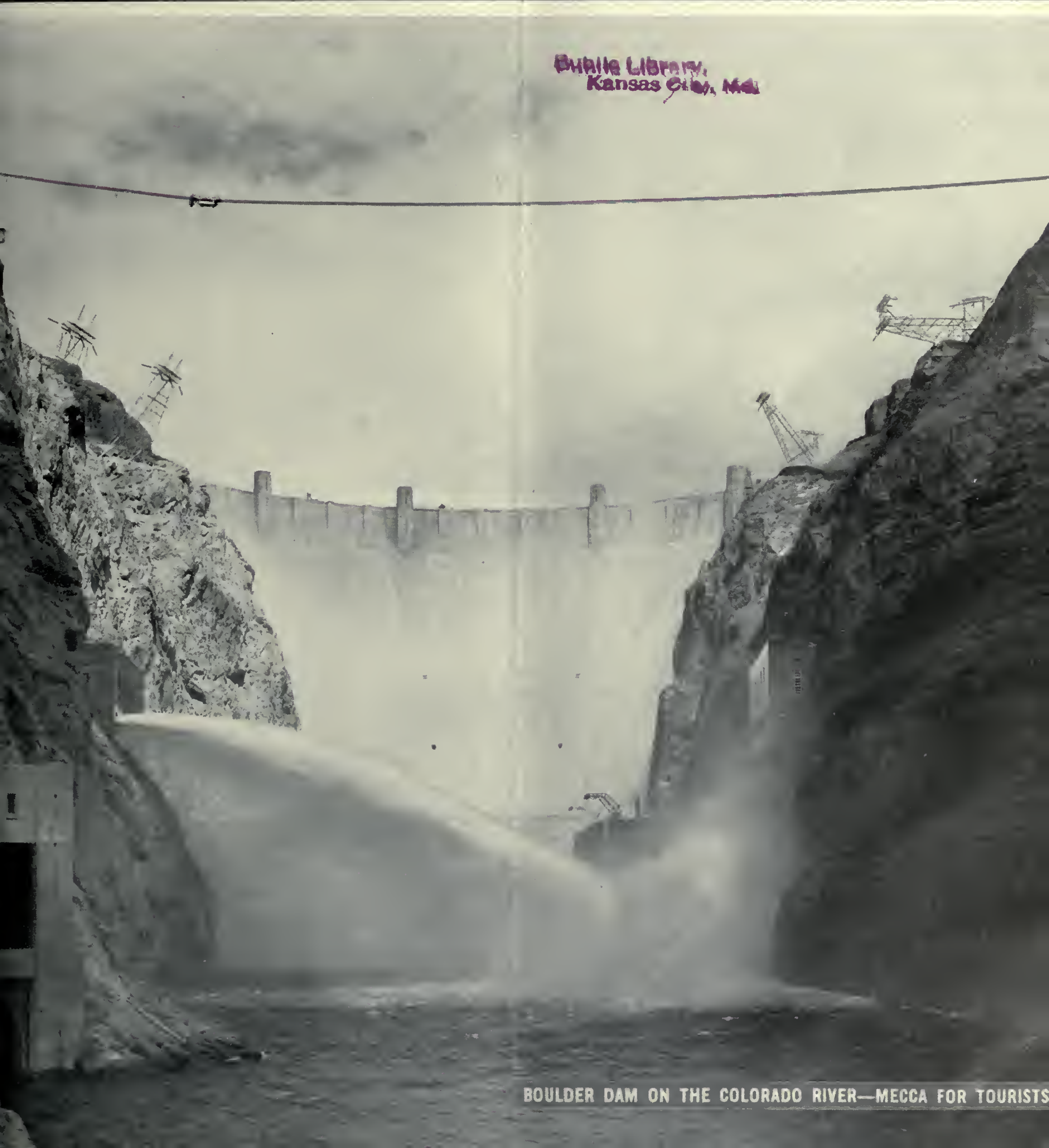

BOULDER DAM ON THE COLORADO RIVER—MECCA FOR TOURISTS

Sacramento River Flood

The Sacramento River flood during March was a graphic and dramatic justification by nature of the multiple-purpose Central Valley project in California.

Walker R. Young, supervising engineer of the project, reported that "several million dollars of damage might have been prevented and some lives saved" in the catastrophe that did $15,000,000 in damage and killed nine, had the Shasta Dam on the Sacramento River above Redding, key structure of the project now under construction, been completed. The Government suffered no serious loss in its construction work, which calls for the completion of the dam in 1943.

The flood, which reached record heights in several localities, originated largely in the watershed of the Sacramento, Pit, and McCloud Rivers above Shasta Dam. Reduction of floods is one of the principal objectives of Shasta Dam.

Had Shasta Dam been completed and in operation, Mr. Young estimated 1,000,000 acre-feet of storage space would have been available when the flood hit. The plan for the dam contemplates reservation of 500,000 acre-feet of storage in the 4,500,000 acre-foot reservoir for floods, and the plan of operation would have made as much more available at the period of the year in which the flood came.

Preliminary estimates show that, had the dam been in operation in this instance, all damage could have been prevented in the vicinity of Redding, where losses amounted to $400,000; and the record peak flow of 290,000 cubic feet per second at Red Bluff could have been reduced by half.

"Below Red Bluff it has not been possible to estimate the dampening effect of Shasta Reservoir accurately without more detailed data," Mr. Young said. "It is believed, however, that the peak at Hamilton City, which is estimated to have approached 300,000 second-feet, would have been reduced substantially—perhaps to half its actual magnitude. Below Hamilton City the contributions of Stony Creek, Chico Creek, and local drainage appear to have caused a maximum peak somewhat in advance of the arrival of the flood crest from above.

"The regulatory effect of Shasta Dam in this locality would have tended to shorten the duration of the flood. Serious damage is attributable to the sustained nature of the flood flow as demonstrated by several levee failures which resulted from prolonged flood stages long after passage of the actual crest. It, therefore, is considered highly probable that a substantial reduction would have been effected in the general overflow in the upper valley, and that breaks in the levees of Reclamation District 70 near Meridian and Reclamation District 1660 south of Meridian, would have been altogether prevented by regulation at Shasta Dam.

"In the lower valley downstream from Tisdale Weir adequate control of the Sacramento River floodwaters was afforded by the existing levee and bypass system."

Shasta Dam is the key structure of the Sacramento River phase of the great Central Valley project. Excavation for its foundation is nearly completed. There were no cofferdams in the river or other temporary structures, except construction bridges, to fail. The principal damage done to project works, apparently, was the settlement of one pier of the long railroad bridge at Redding. This bridge is one unit of the program to relocate the main line of the Southern Pacific Railroad around the reservoir site. The bridge had not as yet been placed in use.

While not so readily dramatized, the waste of a tremendous amount of water into the sea in this flood is a serious loss. Many areas in the Central Valley later in the year will experience a critical need for some of this water for irrigation of orchards and field crops. When the dam is completed and when other project works are in service, this water will not be wasted in destructive floods, but will be stored in large part for use in the dry summer and autumn.

John C. Page,
Commissioner of Reclamation.

PRICE
ONE
DOLLAR
A YEAR

THE RECLAMATION ERA

VOLUME 30 • APRIL 1940 • NUMBER 4

Cooperation—Corps of Engineers and Bureau of Reclamation

By JOHN C. PAGE, *Commissioner of Reclamation*[1]

FOR the construction of its public works on waterways the United States has two well-equipped and well-established agencies, the Corps of Engineers of the United States Army and the Bureau of Reclamation of the Department of the Interior.

This audience needs no introduction to the Corps of Engineers, whose excellent organization and work you have known for many years. The Bureau of Reclamation, however, may not be so familiar to many of you, since it has operated only in the western third of the Nation.

The history and the responsibilities of the Corps of Engineers are known. It will suffice for me to say that the corps for decades prior to the organization of the Bureau of Reclamation was at work in its field of river and harbor improvements. The Bureau of Reclamation was organized in 1902 to build irrigation projects in the arid and semiarid western public-land States. The primary objective of the program was and is to create new homes and new opportunities for American families, and new wealth for the States and the Nation. From the outset the settlers on the new lands have been required to pay for the cost of construction of the irrigation works which serve them. It has also been recognized from the first that there are general public benefits resulting from the development of new lands and new communities.

In the Reclamation Act, now 38 years old, it was stated that the settlers should repay the cost of construction of the irrigation works—this being set up as a measure of their benefits—and that no interest should be charged on the money—this being set up as the measure of public benefits.

The Bureau of Reclamation itself has determined in advance of construction which projects are worthy. No project has been considered feasible that would place on the farmers of the new land a burden in excess of that which they could be expected to repay without undue hardship.

There has never been a variation of this rule, that the project should pay out the cost of construction, except when other considerations have entered and have been given specific recognition by the Congress.

Since its beginning the Bureau of Reclamation has built 160 dams, ranging in size and importance from small diversion structures on the one hand to Grand Coulee and Boulder Dams on the other. The water stored and diverted by these structures has been applied to desert lands to create more than 52,500 farms and to provide homes in towns and on farms for more than 900,000 people.

Wars have been fought abroad over areas of less importance to mankind than these colonies, which we have made for ourselves through the expenditure in peaceful construction of a little more than $300,000,000, of which about $60,000,000 already has been returned to the Treasury through construction repayments. The significance of the reclamation projects in our national economic life can be indicated by citing one fact, that each year these farms which previously were desert turn into commercial channels something over $100,000,000 of new wealth.

When Federal Reclamation first entered the picture 38 years ago, the positions of the Bureau of Reclamation and the Corps of Engineers, generally speaking, were as far apart as the rivers in the West were long. In other words, we were working to irrigate lands on the upper reaches and the minor tributaries, while the Army engineers were working on the lower reaches and the main streams for improvement of navigation.

The progressive development of the West has brought us closer together. Now we find that we have worked downstream and they have worked upstream until in some instances our interests overlap at some midpoint of many of the great western rivers.

What were the influences which sent the Bureau of Reclamation down the rivers, and which sent the Corps of Engineers up the rivers? They are all rooted in the growth of the West, the very growth which was stimulated by the work of the Army engineers and that of the Bureau of Reclamation. Development of new communities created additional navigation needs and additional requirements for control of floods. Exhaustion of surplus waters in the smaller streams through increased irrigation made it necessary for the cities and the farmers of the West to look to the larger rivers for their new irrigation supplies.

It was by a natural evolutionary process that both the Army engineers and the Bureau of Reclamation turned a few years ago to the multiple-purpose project and to consideration of broader water conservation principles to avoid wasteful duplication of effort or head-on collision. It is also proper that we should now cooperate to eliminate friction.

The approaches to problems by the two agencies are different. We came down from the mountains and they came up from the sea, but the two organizations have arranged by mutual and mutually binding agreement to attack these problems at the same time and with the same arms.

One of the arms upon which we both rely, I might add parenthetically, could be strengthened by a more comprehensive program for collection of hydrological data more adequately financed. Sound planning for the use of rivers and intelligent administration of their regulation require reliable records of stages and flows obtained scientifically. These records should be made available for present uses and preserved for future uses by publication in water-supply papers by the Geological Survey.

The agreement is a little broader than this statement might indicate, since the flood-con-

(*Continued on page 98*)

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[1] Address before National Rivers and Harbors Congress March 14, 1940, at Mayflower Hotel, Washington, D. C.

Kendrick Project Power System

By I. J. MATTHEWS, *Resident Engineer*

ITS 400 miles of transmission lines energized, the Kendrick power and irrigation project, in south central Wyoming, has started to pay its way in refutation of some critics who, at the time of the project's inception, scoffed at its chances for a stable economic future.

The power system makes available to municipalities and private utilities power at rates which permit communities and companies to provide services at substantial savings. Moreover, the experience of this system again demonstrates, as had been done in the past, the seemingly strange fact that a supply of electric power develops a demand ahead of and in excess of original expectation.

Before the power plant, transmission lines, and substations were constructed on the Kendrick project, the Government had contracted for the sale of all available firm and dump power. It is estimated that the power plant at Seminoe Dam, lying in a gorge of the North Platte River in the Seminoe Mountain range, will have an average annual output of 140,000,000 kilowatt-hours of electric energy. It should be pointed out that the Kendrick project is feasible as an irrigation venture primarily because the power generated as a byproduct of water storage and conservation will contribute to the repayment of construction charges.

Lines of the new power system were strung in central and southeastern Wyoming, western Nebraska, and northeastern Colorado, and now supply needed additional power to numerous communities in these areas of these three States. Terrain of this country varies. Lines have been erected at altitudes ranging from a maximum of approximately 8,500 feet to a minimum of approximately 3,900 feet. Temperatures during construction varied from 110° F. in midsummer to —30° in midwinter.

Power is distributed from Seminoe power plant over three main lines; one line of 66 kilovolts with 2/0 ACSR conductor goes to Casper, Wyo.; another line of 33 kilovolts with No. 1 ACSR conductor goes to Rawlins, Wyo.; and the third and main line of 115 kilovolts, with Anaconda design No. 24, 250,000-circular-mil hollow copper conductor, goes to Cheyenne, Wyo., by way of Laramie. From Cheyenne the main line branches with one 115-kilovolt line going to Gering, Nebr., and the other 115-kilovolt line going to Greeley, Colo. A 4-kilovolt line from Alcova, Wyo., furnishes power to the Pathfinder Dam, some 10 miles up the North Platte River from Alcova Dam. A 66-kilovolt transmission line from the Casper switching station, connecting with the Casper-to-Midwest line owned by the Stanolind Oil & Gas Co., furnishes supplemental power. The Mountain States Power Co., of Casper, previously constructed and now operates a 57-kilovolt transmission line, approximately 100 miles long, between Casper and the Guernsey power plant, which is the main power plant of the North Platte project power system. This line is made available to the Bureau for interchange of power between the North Platte and Kendrick project power systems.

Major construction of substations at Rawlins and Cheyenne, Wyo., and Greeley, Colo., was completed within the calendar year 1939. The Casper transformer and switching station was assembled as it was needed during the construction of the project. The Gering, Nebr., substation is now being constructed, and the Laramie substation will be constructed during the spring of 1940.

Seminoe power plant bus structure and transformer deck

Seminoe Power Plant

The Seminoe powerhouse building, in the shadow of the 295-foot concrete-arch dam, is a concrete structure 46 feet wide and 128 feet long, which rises 100 feet above its rock foundation, and has an extension on one end of 46 by 30 feet. In the main building are housed three 15,000-horsepower, 225-revolutions-per-minute, vertical-shaft, single runner, Francis-type turbines with spiral casings, three 12,000-kilovolt-ampere vertical-shaft, water-wheel-driven-type generators with direct-connected main exciter and pilot exciter, two 60-inch balanced needle valves, machine shop, a 50-foot traveling crane—running the full length of the building—and, in addition, space is provided for dismantling the transformer and generator units. The extension of the main building contains the control and switch room and space for oil storage and a sump pump. Power transformers for the three outgoing transmission lines, spare transformers, a Petersen coil, three 102-inch ring-seal gates for regulating the flow of water through the turbines, and two 72-inch ring-follower gates for the protection of the needle valves are located in a segmental-rectangular space approximately 40 by 160 feet between the powerhouse building and the dam. On the powerhouse roof are located a 115-kilovolt oil circuit breaker and the high-tension bus structure consisting of a fabricated steel framework. Power will be generated at 6,900 volts and fed to the three outgoing transmission lines through three 667-, three 2,500-, and three 10,000-kilovolt-ampere banks of transformers. All power-plant machinery and equipment were installed by Government forces. The power-plant building, generator foundation, ring-seal gates, penstocks, scroll cases, etc., were erected by Winston Brothers and associated contractors in connection with their contract for the construction of the Seminoe dam and power plant.

Casper-Alcova-Seminoe Line

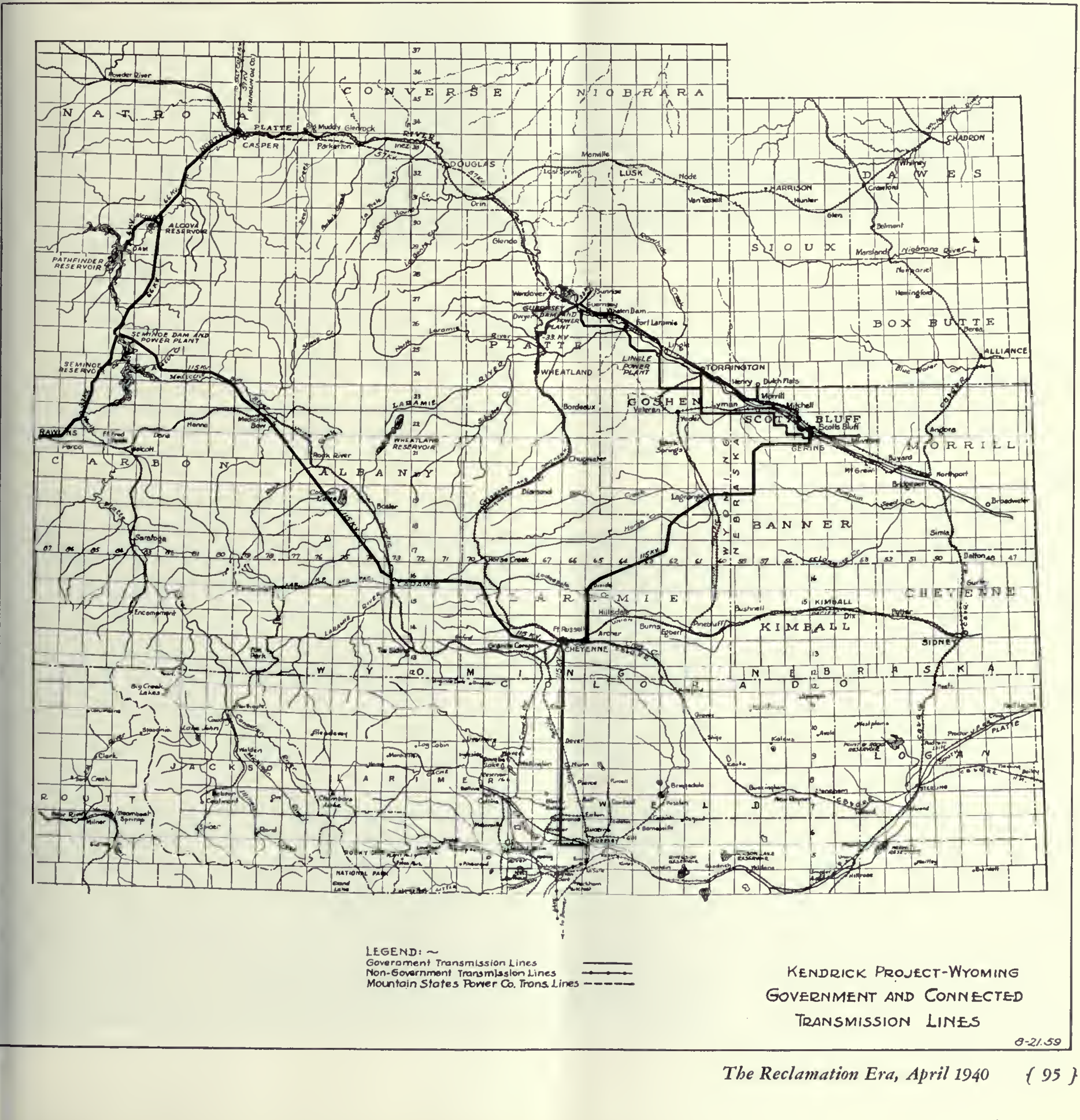
The Casper-Alcova-Seminoe line in central Wyoming was the original sector completed on the system. This line was constructed in 1934 in order to supply power to contractors engaged in driving the diversion tunnel for the Alcova Dam, Tunnels No. 1 and 2 on the Casper Canal, and to furnish power required by the contractor in the construction of the Seminoe Dam and power plant.

The line was constructed of class 2, butt-treated poles whose predominating length was 50 feet. The conductor is 2/0 aluminum cable, steel reinforced, spaced 10 feet between phases, and supported by Pyrex ball-and-socket suspension insulators mounted on standard H-frame type structures. X-type storm guys constructed of 7/16-inch steel cable and turnbuckles were installed along the line at intervals of approximately 2 miles and at points exposed to high winds. Standard treated wood, fishtail type of guy strain insulators were used. The line is 63 miles long and has a designed ground clearance of 26 feet, and an average span length of 660 feet. The design voltage of the line is 66,000, but it is being operated temporarily at 57,000 volts.

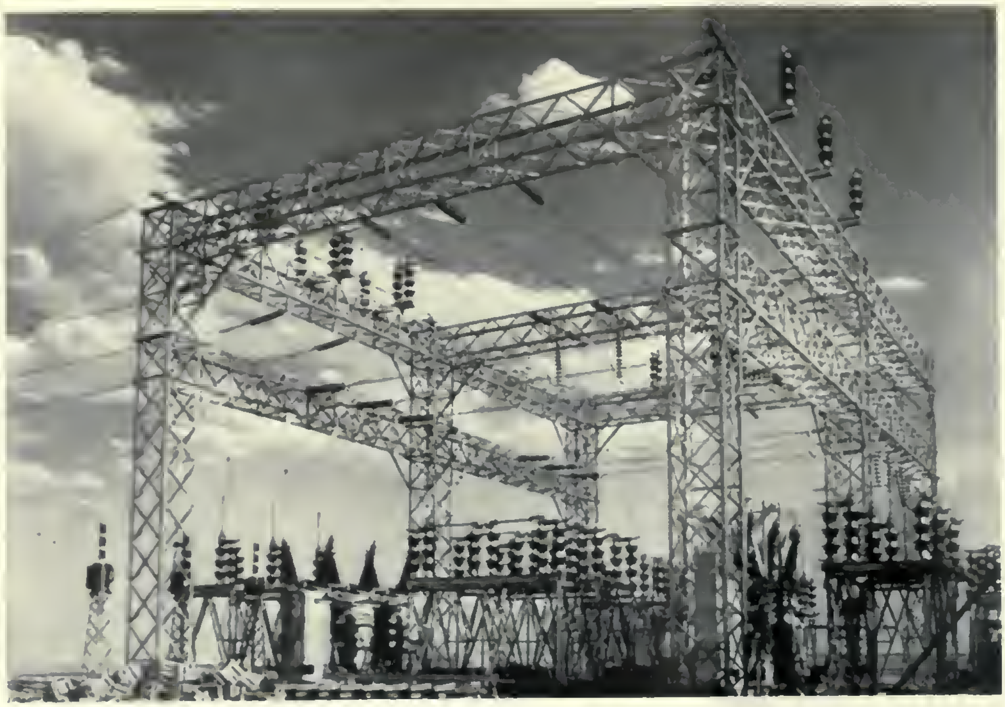
The right-of-way was readily obtained for nominal considerations, as the lands crossed were, for the most part, grazing lands, and the difficulties later encountered when the project system lines crossed farm lands were not present here.

Temporary substations consisting of three 500-kilovolt-ampere, single-phase transformers 66,000/33,000/2,400 ratio with 57,000-volt taps were installed at Alcova and Seminoe Dams for use during the construction period. The stations were adequately protected by Thyrite lightning arresters. Three-pole, gang-operated, air-break, pole-top switches were used to disconnect the substations from the transmission line. The transformers were protected and could be isolated by three single-phase fused disconnecting switches. Power was delivered through outdoor switching and metering cabinets. The Alcova substation was later permanently installed at Rawlins, Wyo., while the Seminoe substation was transferred to Granby, Colo., for use during construction of the Colorado-Big Thompson project.

The Casper switching and metering station is constructed adjacent to the No. 3 generating plant of the Mountain States Power Co., on land owned by the company. The station connects the Casper-Seminoe line to the Mountain States system at Casper and to that company's 57,000-volt transmission line to the Guernsey, Wyo., hydroelectric plant, a unit



KENDRICK PROJECT-WYOMING
GOVERNMENT AND CONNECTED
TRANSMISSION LINES



Cheyenne substation; high tension bus structure

of the North Platte project in eastern Wyoming and western Nebraska. A Pacific Electric Co. 600-ampere, 66,000-volt, 3-pole oil circuit breaker was installed on the Casper-Seminoe line during 1934. No provision for metering at the Casper substation was made at that time, metering being accomplished at the Alcova and Seminoe Dams temporary substations.

In 1936 the additional load of the Government-owned and operated draglines necessitated provision of supplemental power which was obtained by a 57,000-volt transmission line 2.2 miles long, connecting the No. 3 plant and the Government's switching station to the Casper-Midwest transmission line of the Stanolind Oil & Gas Co. A Condit 600-ampere, 3-pole oil circuit breaker was installed for switching the load connected to the Casper-to-Midwest line. Two 66,000-volt current transformers and potential transformers with 57,000-volt taps were installed on the Stanolind interconnection for metering the supplemental power.

When delivery of power from the Seminoe power plant to the Mountain States Power Co., at Casper, Wyo., was inaugurated on August 3, 1939, it became necessary to provide for metering the incoming and outgoing power transmitted over the Casper-Seminoe transmission line. It was also necessary to provide for a high voltage connection to the new 3-phase, 66,000-volt 5,000-kilovolt-ampere transformer and the 500-kilovolt-ampere, 4,000-volt regulator which had been purchased and installed by the Mountain States Power Co. to feed a newly enlarged 4,000-volt distribution system for the city of Casper.

The new transformer is provided with sufficient taps to operate at the present 57,000 voltage. In December 1939, Government forces completed the installation of three 66,000-volt current transformers and potential transformers with 57,000-volt taps and a revised bus system which connects the 57,000-volt Casper-Guernsey line, the 57,000-volt Stanolind tie line, the 3-phase transformer, the 66,000-volt Casper-Seminoe line (now operating at 57,000 volts), and metering equipment for the Casper-Seminoe line which is mounted on a new panel located in the No. 3 plant of the power company.

During construction of the Casper Canal by four Government-owned-and-operated draglines, temporary substations consisting of three 100-kilovolt-ampere transformers were connected to the Casper-Seminoe transmission line at points adjacent to dragline operation. After completion of the dragline excavation, one of the temporary substations was permanently installed at Alcova. The others were transferred to various locations on the Colorado-Big Thompson project.

Alcova-Pathfinder Line

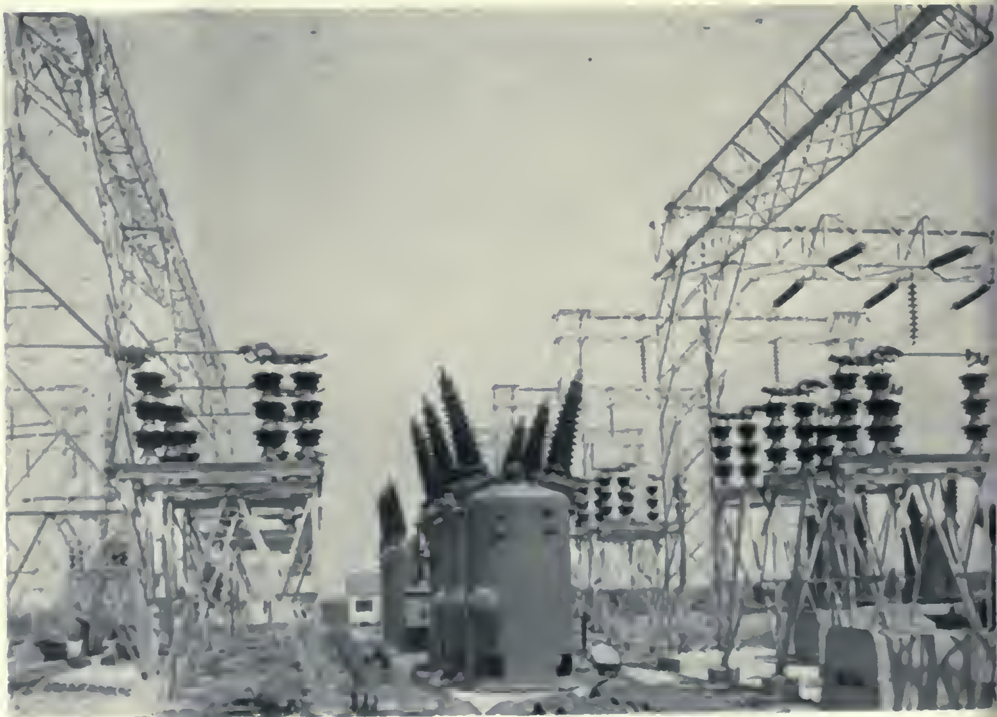
In the spring of 1937 the Alcova-Pathfinder transmission line, which is of 3-phase, single-pole, 4,000-volt construction, was constructed by Government forces. No. 2 ACSR aluminum conductor is supported on 30-foot poles with an average span length of 292 feet and a ground clearance of 20 feet. Pin-type 14,000-volt insulators were used.

Power is supplied from the permanent Alcova substation to a temporary feeder to the Alcova Dam spillway operating machinery, the Casper Canal headworks, and to the operating equipment at Pathfinder Dam.

Seminoe-Rawlins Line

The Seminoe-Rawlins transmission line was completed by Government forces in December 1938 and was energized on December 16, 1938, in order to supply the Rawlins Electric Co.

Greeley substation; 115-kilovolt oil circuit breaker and disconnecting switches



with temporary stand-by and peak-load generation from the Mountain States Power Co. at Casper.

Delivery of power from the Seminoe power plant was started on August 8, 1939, over the permanent set-up, being fed from the three 667-kilovolt-ampere transformers located at the Seminoe power plant. Single-pole, pin-type insulators with one ridge pin per pole predominated. Standard H-frame structures 10 feet between phases were used on long spans. Poles 35 feet long were erected with average conductor spans of 380 feet and 20 feet designed ground clearance.

Cheyenne-Greeley Line

Construction of the Cheyenne-Greeley transmission line, by Government forces, was started late in 1938 before the Seminoe Dam-Cheyenne line had been constructed and before power was available from the Seminoe plant in order that the Public Service Co. of Colorado would be able to supply power temporarily to the city of Cheyenne. The temporary connection was never made as the anticipated Cheyenne load did not materialize.

Standard H-frame type of construction with an average pole length of 55 feet, span length of 600 feet, and designed ground clearance of 28 feet, was used throughout. Anaconda design No. 24, 250,000-circular-mil stranded copper, internal I-beam conductor was supported on seven bells of porcelain ball-and-socket type suspension insulators.

A rather interesting innovation in the way of construction equipment on this line was the 42-foot boom mounted on the rear of a D8 Diesel Caterpillar tractor equipped with bulldozer. The boom was operated from a double-drum power take-off mounted on the rear of the tractor, while the bulldozer was controlled by a single-drum unit mounted in front of the radiator. Poles were framed and gained on the ground. Crossarms, insulators, and ground wires were completely assembled before erection. This machine was capable of smoothing a road to the structure locations, leveling a hoisting location to be used during erection of the structures, and lifting a 65-foot structure with all crossarms and insulators completely assembled. The unit averaged two structures per hour over the entire job with a maximum accomplishment of three structures per hour. Wire was strung from the 7,000-pound reels by three reel carts constructed in the Casper shops. These carts were of welded steel construction equipped with truck wheels using 38 by 7 tires and spaced 7 feet apart.

115-kilovolt transmission line. Typical H-frame cross-brace structure on summit of mountain between Laramie and Cheyenne

Incidents out of the ordinary experienced during the construction of this sector included heavy static discharges and the difficulty of properly tamping poles to prevent leaning. Both of these were caused by extremely high winds which prevailed from the southwest at approximate right angles to the transmission line. It was found necessary solidly to ground conductors at intervals along the line during construction to drain off wind static during periods of high wind.

While extreme care was exercised in tamping the poles, the prevailing winds blew with such force (velocities exceeding 55 miles per hour) that it was necessary to install additional treated wood X-braces and retamp the poles, using pneumatic tampers operated from a portable truck-mounted compresser. The results of tamping by pneumatic tampers were far superior to the best hand tamping.

Erecting 3-pole angle structure on Seminoe Dam-Cheyenne transmission line

Cheyenne-Gering Line

The line from Cheyenne, Wyo., to Gering, Nebr., was built by contractor Fritz Ziebarth. Work started on this sector in October 1938 and was completed in April 1939, under Specifications No. 799. The line is 93.7 miles long; it has H-frame type of structures with No. 4/0 ACSR aluminum conductor supported by porcelain, ball-and-socket type suspension insulators similar to the Cheyenne-Greeley line.

High wind difficulties were experienced during this work as had been encountered on the Cheyenne-Greeley sector and the same trouble with leaning poles had to be corrected. After the contract was completed, therefore, all leaning poles were retamped using pneumatic tools, by Government forces—hand tamping only having been a requirement of the contract.

It was necessary to relocate approximately 20 miles of the Cheyenne-Gering line, a distance of 5½ miles from the Cheyenne airport in order that there could be no possibility of future interference with the airport radio equipment, expansion of the post's facilities, etc.

Seminoe Dam-Cheyenne Line

The 142-mile Seminoe Dam-to-Cheyenne transmission line, constructed by the Larson Construction Co. under Specifications No. 819 was started in March 1939 and completed in August 1939. This main line was tested for an 8-hour period in November 1939, and appeared to operate in a satisfactory manner. The test was extended through the Cheyenne substation to the Greeley line at this same time. Anaconda design No. 24 copper conductor was used and the structures were identical with those erected on the Cheyenne-Greeley line. Having anticipated wind difficulties, tamping was performed with pneumatic tools and a large number of X-braces and guys were installed.

Authorization has been granted for the construction of a 120-mile, 66,000-volt line from Casper to Thermopolis which will serve to interconnect the Shoshone-Riverton hook-up with the Kendrick-North Platte system and thereby form a correlated power system to provide stand-by power in case of shortage on any of the four projects, and facilitate more efficient handling of the available supply. Consideration is being given to the desirability of constructing a line from Thermopolis to Cody to complete the circuit between the four projects.

The acquisition of rights-of-way across grazing areas of long standing, moderately developed farming country, and intensively developed farm lands near Greeley, Colo., and Gering, Nebr., presented various problems. In general, the attitude of the landowners favored the construction of the transmission lines and informal consent was readily given to construct the lines at a certain price per structure until it was discovered that the farms adjacent to the right-of-way could not be connected to the 115,000-volt line because of the prohibitive cost of constructing the necessary substations. At the present time negotiations acceptable to both the United States and the landowners or complete acquisition have been effected to 95 percent of the rights-of-way.

Condemnation was resorted to in but two cases; one at the request of the landowner to facilitate clearing title in connection with an involved estate and the other because the landowner repudiated his informal agreement when he was informed that power could not be made available to his various ranches. The latter case was subsequently settled out of court after the transmission line was completed.

115-kilovolt Substations

All substations constructed to date have been built by Government forces. Power is supplied to the 115-kilovolt-ampere transmission lines by three 10,000-kilovolt-ampere transformers at the Seminoe power plant. The system is connected to the 33-kilovolt-ampere lines and 6,000-kilovolt-ampere synchronous condenser at Gering, Nebr., by three 2,000-kilovolt-ampere transformers and to the system of the Public Service Co. of Colorado at Greeley, Colo., by three 5,000-kilovolt-ampere transformers. Intermediate substations of three 2,500-kilovolt-ampere transformers now installed at Cheyenne, Wyo., and three 2,500-kilovolt-ampere transformers which will be installed at Laramie, Wyo., will feed Cheyenne and Laramie, respectively. A 3-phase voltage regulator is used to control the voltage at Greeley, Colo. Voltage regulators will be used in supplying current to Cheyenne and Laramie, Wyo.

The system is protected from interruption by the installation of ground fault neutralizers, termed Petersen coils, at the Seminoe power plant and the Gering and Greeley substations.

Control houses and combination warehouses and garages were built at Cheyenne and Gering. A cable control circuit was strung on company poles from the Cheyenne substation to the Cheyenne steam plant, a distance of about 2 miles. Fences were constructed around all substations.

Carrier Current

Communication for switching and load dispatching on the power system is carried on over a carrier-current telephone system. The main switchboard of this system is located in Seminoe power plant. The system is comprised of a loop circuit from Seminoe to Casper and Guernsey, Wyo., to Gering, Nebr., and from Seminoe to Cheyenne, Wyo., to Gering, Nebr., with a circuit extending to Greeley, Colo., from Cheyenne, Wyo. Conversations may be routed through either Gering or Seminoe to any point on the circuit.

Cooperation

(Continued from page 93)

trol studies of the Department of Agriculture also are involved, and therefore the Bureau of Agricultural Economics is included as the third party. The National Resources Planning Board is our clearing house and has certain responsibilities for coordination of the work. Here, however, the principal interest is in cooperative methods of the investigating agencies. I will outline it in more detail.

Each of these agencies notifies the others when an investigation of a proposed multiple-purpose project is to be instituted; each advises the others if they have any direct responsibility in a project another is studying; and all exchange data and information. The investigational work is divided, each doing that part for which it is best qualified. The reports are jointly reviewed while still in tentative form.

Like boatmen coming from opposite shores and meeting in the middle of a river, the Army engineers and the Bureau of Reclamation, for example, can exchange information, reach certain conclusions with respect to the river, its character, and its usefulness, without either of them having to row clear across. The boatmen could, if they had confidence in the others' judgment, meet half way and be satisfied. The Corps of Engineers and the Bureau of Reclamation are meeting half way.

Obviously this does not eliminate entirely the possibility of a divergence of views. It is not necessary nor desirable that it should. The laws and regulations governing each of us are different. The primary emphasis, for example, in the work of the Bureau of Reclamation and in that of the Corps of Engineers is on different objectives.

It gives me pleasure, however, to be able to say that in the investigations and reports on multiple-purpose projects, the Corps of Engineers and the Bureau of Reclamation have cooperated and do cooperate, and that as a result there is virtually no waste of effort. We are usually in accord on the method of developing the river, on the benefits, on the engineering features, and on the costs of the construction. The men of these agencies are trained and expert in different fields, and the people of the West and the United States are better served by mutual cooperation.

I have the greatest faith in the judgment and conclusions of the experts of the Bureau of Reclamation in calculations of the potential irrigation and power uses of a given river or of a given structure, but for navigation I believe the experts of the Corps of Engineers have the highest qualifications.

The question might be asked, "Well, then, who builds and operates the multiple-purpose project you jointly plan?"

The President recently gave the best answer when he said that the dominating interest should govern.

Let us assume, as I believe you will agree to do, that either the Corps of Engineers or the Bureau of Reclamation can build a dam and a power plant with equal efficiency, then a multiple-purpose dam of major irrigation benefit should be constructed by the Bureau of Reclamation, and a similar dam with major navigation benefits, for example, should be built by the Corps of Engineers. On the Columbia River there are two large multiple-purpose dams. Grand Coulee Dam, which will serve to irrigate 1,200,000 acres and incidentally generate a large block of power, improve navigation, and reduce flood peaks, among other things, is being built by the Bureau of Reclamation. Bonneville Dam, farther downstream, is a major aid to navigation, and incidentally it generates a large block of power. It was constructed by the Corps of Engineers.

It has been a pleasure to work with the Corps of Engineers. I can foresee that there will likely be many more occasions for us to cooperate in the future than there have been in the past. I look forward to these opportunities with pleasant anticipation.

Milk River Community Life

ON the Milk River project, community activity is apparent principally on the South Wagner Farm Security Administration area, where excellent social facilities are provided. During the month of February, eight 4–H Club meetings and social functions were held at the community center, with an attendance varying from 56 to 90. At one community dance there were 170 present.

The annual winter extension schools were conducted at Zurich, Malta, and Glasgow, and of particular benefit to project development was a discussion of weed control and irrigated pastures by an extension specialist from the State college. These meetings were well attended by project farmers and much interest was displayed in the establishment of pastures.

Melted snow from Mount Shasta and torrential rains caused the worst spring flood of the Sacramento River in 60 years. Shasta dam site, busy scene of work aimed at preventing such floods, saw temporary bridge washed out, the excavation filled with water. (See opposite page)

Origin of Names of Projects and Project Features in Reclamation Territory

THIS article is No. 2 in the series on the above subject, No. 1 having appeared in the March issue of the ERA. We are now considering the Central Valley, Columbia Basin, and Deschutes projects.

Central Valley Project, California

THE Central Valley project area is roughly the Great Central Valley, a geographical designation for the large interior valley of California, comprising the basins of the Sacramento and San Joaquin Rivers. The proper names, with their derivations, of 22 of the principal project features, are listed as follows:

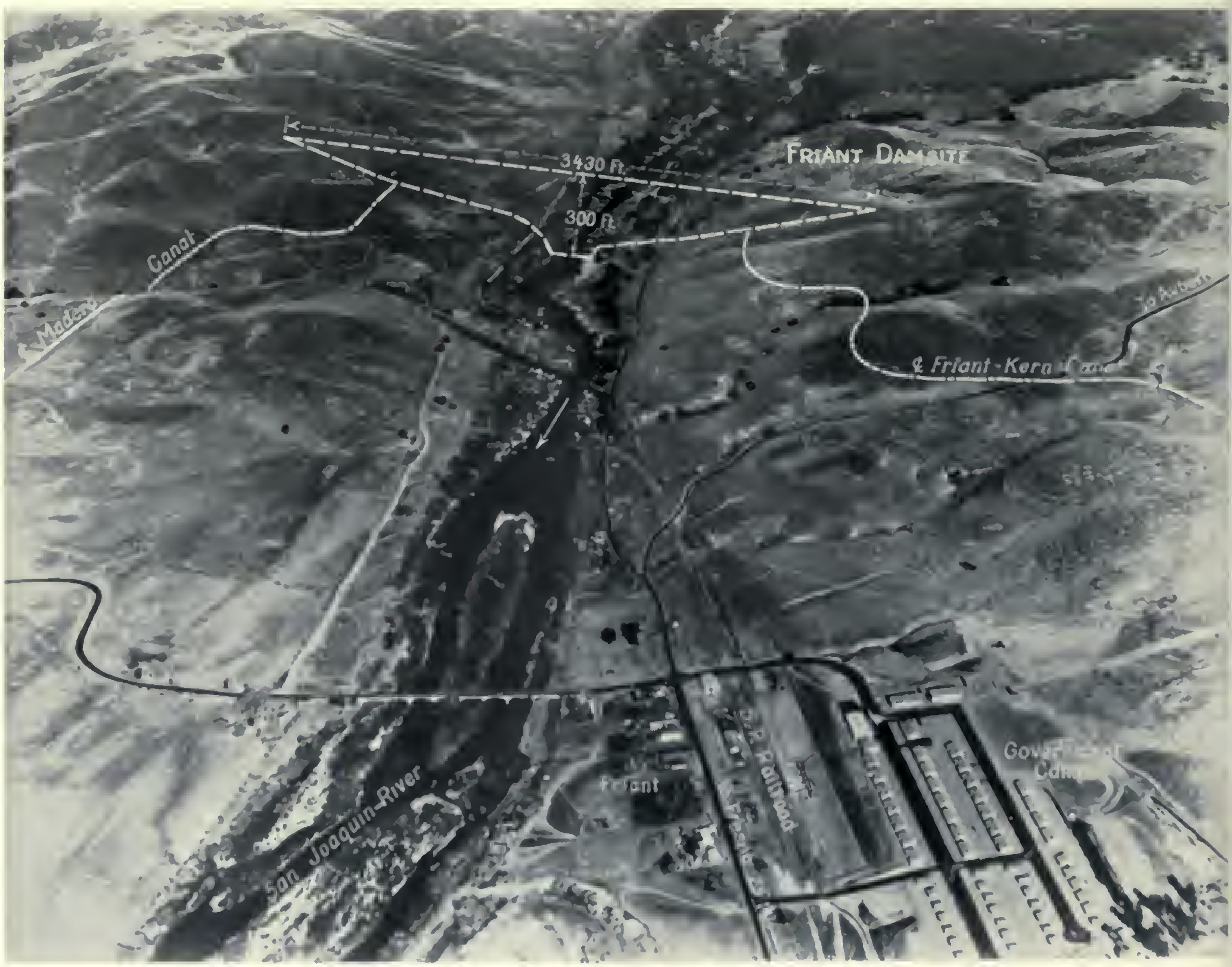
Antioch.—This is the headquarters city of the Delta Division. The name comes from the Greek City of Antioch.

Chico.—The name of the second largest city in the Sacramento Valley is of Spanish origin and means "little." The name was derived from General Bidwell's Rancho del Arroyo Chico, or Ranch of the Little Creek.

Contra Costa Canal.—So named for the county in which the canal is located, on the east shore of the San Francisco Bay. Contra Costa is Spanish for "opposite coast," and signifies its position as being opposite to the early settlements of Benicia, Vallejo, and San Francisco.

Delta Division.—A geographical designation

Aerial view of Friant dam site



referring to the common delta of the Sacramento and San Joaquin Rivers.

Feather River.—An important tributary of the lower Sacramento River, this river was called Rio de las Plumas, or River of the Feathers, by Don Luis Arguello, who discovered quantities of wild pigeon feathers floating on its surface.

Fresno.—This, the largest city of the San Joaquin Valley, obtained its name from the Spanish word "fresno," meaning ash tree, which grew in abundance in the vicinity.

Friant Dam.—The dam and project division are named for the town of Friant, located just downstream from the dam site. Originally called Mugginsville, then Hamptonville, and later Pollasky, the town failed to prosper and the residents sought a new name for a change in luck. When the White and Friant Lumber Co. extended the railroad from Pollasky to timber holdings in the mountains, the appreciative citizens honored one of the owners, H. A. Friant, by taking his name for the town. The boom expected of Friant many years ago failed to materialize until 1939, when work was started on Friant Dam.

Kennett Division.—The name of this division was taken from the original designation of the present Shasta dam site as the Kennett site, which was named from the "ghost town" of Kennett, about 3 miles upstream. The town was created as a railroad station in 1884, and thrived as a copper mining center from about 1906 to 1920. It was named after Squire Kennett, one of a group of stockholders of the old Central Pacific Railroad who made an inspection trip to the place when the railroad first was located through the canyon.

Kern County.—Named from a pioneer family, Kern County is a subdivision of the original Tulare County. The Friant-Kern Canal is named from its geographical limits, Friant on the north and Kern County on the south.

Kings River.—This important stream in the southern valley was called, by the Spaniards who discovered it in 1805, El Rio de los Santos Reys, or the River of the Holy Kings, in honor of the Three Wise Men.

Madera Canal.—So named for the county in which it is located. Madera means timber in Spanish. The county obtained its name from its large stands of pine and fir.

Merced River.—This important tributary of the lower San Joaquin River was called El Rio de Nuestra Senora de la Merced, or the River of Our Lady of Mercy, because of the joy Capt. Gabriel Moraga felt when he and his company drank of its refreshing waters after traveling many miles through a waterless country. The city and county of Merced are named from the river.

Modesto.—This city in the northern San Joaquin Valley obtained its name from the Mexican for modest, because William C. Ralston, a railroad financier, declined the suggestion that the town site be designated Ralston.

Pit River.—The largest tributary of the upper Sacramento River was so named because the Modoc Indians dug conical pits with a small opening covered with brush and a bottom set with sharp stakes to trap and impale bear, deer, and hostile tribesmen.

Redding.—The present seat of Shasta County and closest city to Shasta Dam. The name "Redding" is an early map maker's misspelling of the name "Reading," chosen to honor Maj. P. B. Reading, a pioneer settler.

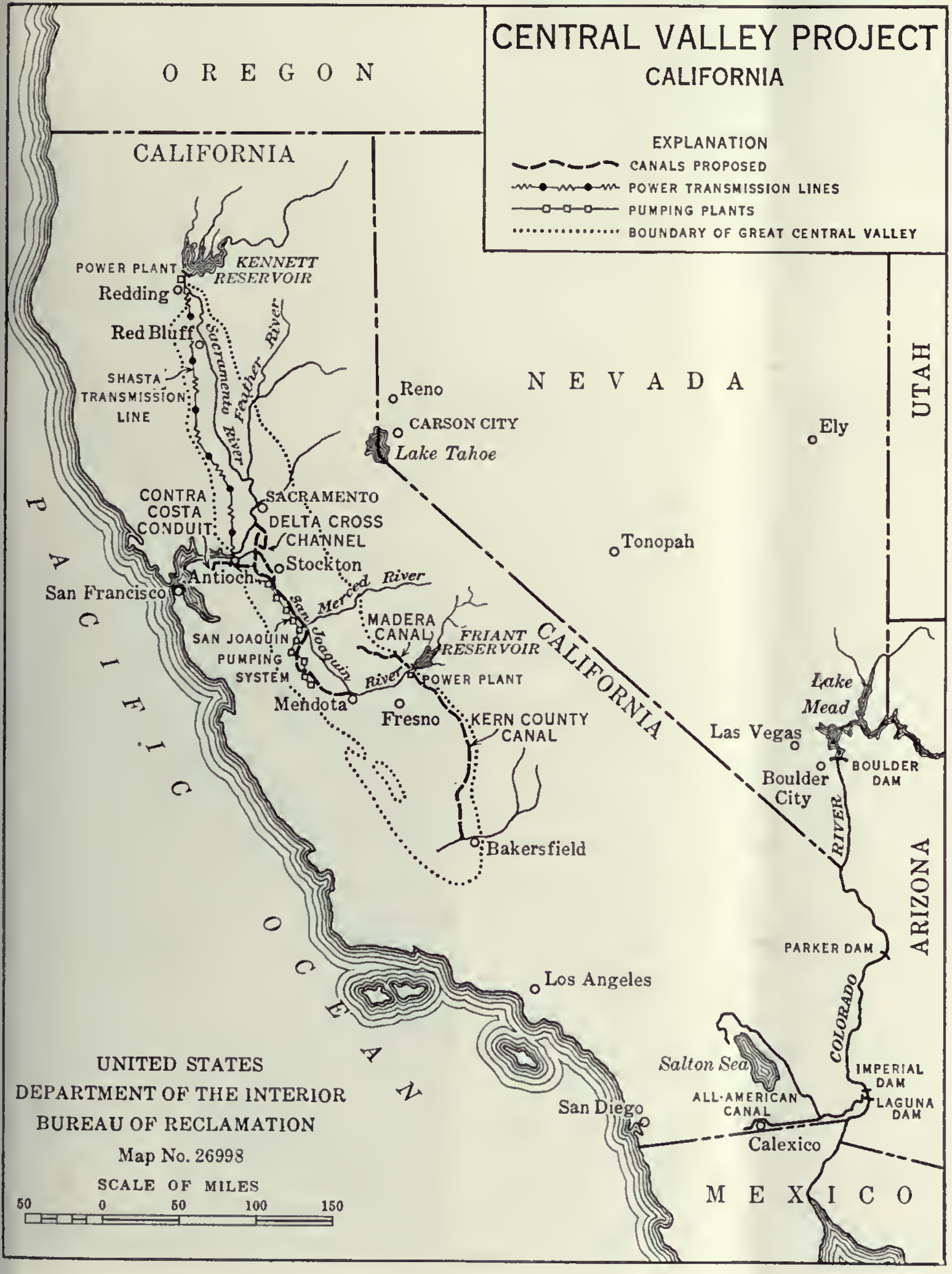
Sacramento River.—This name, derived from the Holy Sacrament of our Lord's Supper, originally was given to the present Feather River by Capt. Gabriel Moraga, Spanish explorer, and later applied by Moraga to the main stream which had been called Jesus Maria. The city of Sacramento, capital of California and headquarters of the Central Valley project, is named from the river.

San Joaquin River.—Named by the Spaniards for St. Joaquin, father of the Virgin Mary.

Shasta Dam.—Like the county in which it is located, Shasta Dam takes its name from Mount Shasta, 14,161-foot peak of perpetual snow which can be seen from the dam site and many parts of the reservoir area. Shasta is from the Russian word "tchastal" meaning white or pure mountain, so designated by the Russians who settled on the north coast of California in the early part of the nineteenth century.

Sierra Nevada Mountains.—From the Spanish, sierra, meaning saw, and nevada, meaning snowy, or snowy saw-toothed mountains.

Stockton.—An important city of the delta area named after Commodore Robert Field



Metaline Falls on the Pend Oreille River, Washington

Stockton, of the U. S. frigate *Congress* which participated in the naval engagements while California was being wrested from Mexico.

Toyon.—The Bureau of Reclamation camp near Shasta Dam is named for the toyon berry bushes which grow in profusion in the vicinity. Toyon is from an Indian word, "tollon," meaning red berry.

Tulare County.—The upper or southern San Joaquin Valley originally was called the Tulare Valley from the Spanish Valle de los Tules, another name bestowed by Capt. Gabriel Moraga because of the prevalence of tules or rushes.

Columbia Basin Project, Washington [1]

Big Bend.—This name refers to the bend in the Columbia River.

Clark Fork.—Named Clark River by the Lewis and Clark expedition of 1805–6.

Coeur d'Alene.—French name for Indians, meaning awl or stone hearted.

Columbia River.—Named by Capt. Robert Gray (the American discoverer of the river) for his ship *Columbia*, May 19, 1792.

Colville.—Derived from Andrew Colville, who succeeded Sir John H. Pelly as Governor in London of the Hudson's Bay Co.

Coulee.—Webster's dictionary says "the bed of a stream, even if dry, when deep and having inclined sides." From French Coulée, meaning "to flow."

Entiat.—Indian name meaning rapid water.

Ephrata.—This name, which probably means fruit region or fertile ground, was given by the Great Northern Railway surveyors. This was the ancient name for Bethlehem, the birthplace of Jesus.

Hellgate.—So named for the strong rapids.

Inchelium.—An Indian name meaning "where little water meets big water."

Kettle Falls.—Thus named because the Indians used baskets for fish. They called these baskets "Ilthe-Kape," meaning kettle. A further significance is that the falls boil like water in a kettle.

Marcus.—Named for Marcus Oppenheimer who filed a homestead there.

Meyers Falls.—Named for Louther Walden Meyers, who took possession in June 1866, having leased Hudson's Bay mill property.

Moses Lake.—So named because Chief Moses' tribe used its shores for campground.

Nespelem.—An Indian name meaning a large meadow beside a stream.

Okanogan.—Tribe of Indians. Means rendezvous.

Omak.—From Indian "Omache," meaning great medicine, referring to the supposed curative qualities of Lake Omak.

Pasco.—A name bestowed by Virgil Gay Bogne, location engineer of the Northern Pacific Railroad. Because he had read of a town in Mexico that was hot, dusty, and disagreeable, he gave the same name to this site. Another story is that Harry McCartney (associated with Bogne) named it by way of contrast. Pasco was the flattest, hottest place he had found while Cerro de Pasco, Peru, was the highest and coldest place he had ever seen.

Pend Oreille.—This name, which means earbobs, was given by the French to the Indians who wore pendants from the ears.

Soap Lake.—So named because the water is very soapy.

Spokane.—An Indian tribe. The name means children of the sun.

Steamboat Rock.—So named because the rock resembles a steamboat.

Washtucna.—Named for a Palouse Indian Chief.

Wenatchee.—An Indian name meaning "river issuing from a canyon."

Yakima.—The name of an Indian tribe. There are many meanings—black bear, people of the narrow river, and lake water.

The Spokane Chronicle gives a brief list of additional names of places in the State of Washington which were derived from the Indians. This list is as follows:

Asotin County.—From an Indian word for "eel creek."

Chehalis.—From a Chinook Indian word meaning "beaver."

Clallam.—An Indian word for "strong people."

Kitsap County.—Named after an Indian Chief, the word "Kitsap" meaning "brave."

The Pend Oreille River. Looking downstream at the outlet of Z Canyon

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[1] Much of the information concerning the Columbia Basin proper names was obtained from Cowles Reference Library of the Spokesman-Review.

The east rapids on the Columbia River at Kettle Falls, Washington

Kittitas County.—From an Indian word meaning "gray gravel bank."

Skamania County.—From an Indian word meaning "swift water."

Deschutes Project, Oregon[2]

Agency Plains.—So called because they were near the agency of the Warm Springs Indian Reservation.

Bend.—For the greater part of its course the Deschutes River is in a canyon with walls so steep as to make access to the water difficult. At a point on the river, however, where now the Brooks-Scanlon Co. mills stand, the river was out of its canyon walls and bordered by a meadow. Early travelers sought this spot on the river after crossing the desert to graze and water their stock. Thence, proceeding south they went up a hill from which point, looking back, they saw a bend in the river. This they called Farewell Bend, which name has since been shortened to Bend.

Crane Prairie.—So called because of the number of cranes found in the vicinity.

Deschutes.—In the fur-trading period beginning in the twenties of the past century the name Riviere des Chutes was given to the river. Fremont in his report of his exploration in 1843 called it simply Fall River. McArthur favors the theory that the river was given the name because it flowed into the Columbia just above The Chutes or The Dalles. The belief of Robert W. Sawyer, editor of The Bend Bulletin, is that the name Deschutes, or River of the Falls, was based on the fact that there were many falls in its course to the Columbia.

Madras.—Named by United States postal authorities, probably from the city in India by the same name.

Redmond.—Named for Frank T. Redmond, who settled near the present site of the town in 1905.

Wickiup.—This is an old stockman's name for a point of the Deschutes River south of Crane Prairie. The place was a camping ground for Indians who gathered there to hunt and fish in the fall. They left their wickiup poles standing, which gave the place its name. (NOTE.—A wickiup is a loosely constructed hut made of boughs of trees interlaced, used for the time being by some tribes and left standing when abandoned; opposed to tepee or wigwam.—*New Standard Dictionary.*)

Sun River Livestock

LIVESTOCK on the Sun River project, Montana, is in good shape, with a demand for good dairy cattle.

Grassy Lake Reservoir Completed

GRASSY LAKE storage reservoir, in northwestern Wyoming, was completed late in February and brings the total number of Federal Reclamation reservoirs now in operation throughout the West to 72. Two more, Crane Prairie on the Deschutes project, Oregon, and Vallecito on the Pine River project, Colorado, are expected to be added this year.

Although Grassy Lake is comparatively a small reservoir, with a maximum storage capacity of only 15,200 acre-feet, its addition is regarded as very helpful to the Upper Snake River region, which has been laboring under inadequate irrigation supplies. During the past few weeks it has accumulated 1,305 acre-feet, or 425,000,000 gallons of much needed water for irrigating Upper Snake River farm lands, with present indications of enough snow on the drainage basin to fill it this spring.

The 71 Bureau of Reclamation reservoirs in operation at the beginning of the year had a total storage capacity of 29,818,772 acre-feet, or nearly 1 trillion gallons. Water storage on all Reclamation projects this year is 2,628,631 acre-feet lower than at the beginning of 1939, however, despite the entrance into active service of four other new reservoirs during the 1939 season. The decrease is due primarily to a summer drought in many parts of the West more severe than any since 1934, and a fall drought worse than any ever recorded by the Weather Bureau.

The four new reservoirs which first saw service during 1939 were: Fresno on the Milk River project, Montana; Boca on the Truckee River project, California-Nevada; Seminoe on the Kendrick project, Wyoming; and Bartlett on the Salt River project, Arizona. They added 1,334,673 acre-feet, bringing the total capacity of all Federal Reclamation reservoirs at the beginning of 1940 to 60,272,640 acre-feet.

The effect of continued drought years and the small run-off from mountain streams has been felt in a large part of the West, and the additional reservoirs completed in time to help out during the 1939 season were very welcome. In one instance, that of Bartlett Reservoir on the Verde River in Arizona, the new reservoir actually saved the day for the irrigators. Bartlett accumulated enough water within 120 days after the completion of the dam to warrant general rejoicing among the Salt River Valley water users, plagued by water shortage.

Despite the extended droughts throughout the West, Belle Fourche in South Dakota was the only Reclamation project that experienced serious water shortage in 1939.

Yuma Project Crops

HARVESTING of lettuce, carrots, and cabbage on the Yuma project continued during February at an accelerated rate. Picking of the 1939 season's cotton crop was completed early in the month. Seven bales of cotton were ginned on the project, making the season's total 3,748 bales, of which 179 were from the Gila project. Many flax fields were in bloom at the close of the month, and cantaloupes and watermelons had been planted.

Conservation Bulletins, Department of the Interior

BULLETIN NO. 1: Attracting Birds, Bureau of Biological Survey. Bulletin No. 2: Farmer's Irrigation Guide, Bureau of Reclamation. Bulletin No. 3: Wild Life Conditions in National Parks, National Park Service.

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[2] Except where otherwise stated the information concerning the derivation of the several project feature names in this list was found in McArthur's Oregon Geographic Names.

Power Production at Boulder Power Plant Increasing Rapidly

By IRVING C. HARRIS, *Director of Power*

THE first main generating unit of the Boulder power plant went into regular service on October 22, 1936. The construction forces were under much pressure to get this unit into operation at the earliest possible date. This was due to the rapidly growing demand for electrical energy in southern California. At the present time, eight 82,500 and one 40,000-kilovolt-ampere generating units are in regular service. Throughout the entire period of the installation of the nine units, the demand was such that the several units had to be installed as rapidly as possible to meet the needs of the power contractors. In the case of the last two units installed, each was put into service under full load, 24 hours a day, 30 days a month, as soon as it was ready for regular service.

The several units of the plant were put into operation on the following dates:

Unit N-2, October 22, 1936.
Unit N-4, November 14, 1936.
Unit N-1, December 28, 1936.
Unit N-3, March 18, 1937.
Unit A-8, August 16, 1937.
Unit N-5, June 26, 1938.
Unit N-6, August 31, 1938.
Unit A-7, June 19, 1939.
Unit A-6, September 12, 1939.

Units A-6 and A-7 supply energy to the Southern California Edison Co., Ltd. The company's other sources of energy consist of a number of large hydroelectric plants on streams in the Sierra Nevada Mountains, a number of small plants on streams in the Sierra Madre and San Bernardino Mountains of southern California, and a large steam power plant at Long Beach, Calif.

The company serves consumers in seven counties of southern California. There is an interconnection between the systems of the Edison Co. and the Pacific Gas & Electric Co., through the system of the latter's subsidiary, the San Joaquin Light & Power Corporation, by means of which energy may be interchanged between the systems as needed to make up for shortages and to dispose of surpluses to the best advantage.

The snowfall during the winter of 1938-39 on the watersheds of the streams in California was much below normal, resulting in a water shortage and a consequent shortage of hydroelectric power in that State. This greatly increased the amount of energy that had to be generated by the available steam power generating plants. Under the terms of its contract with the Government, the Edison Co. is obligated to commence taking energy from the Boulder power plant on June 1, 1940. The growth of the company's load and anticipation of the possibility of a power shortage caused it to request that facilities for furnishing energy to it be made ready for service many months in advance of that date. As it became apparent that there would be a serious water shortage and consequent power shortage during the year 1939, the completion of the installation of the two units for supplying the Edison Co., at its request, was speeded up as much as conditions would permit with the result that the first unit was ready for service on June 19 and the second on September 12.

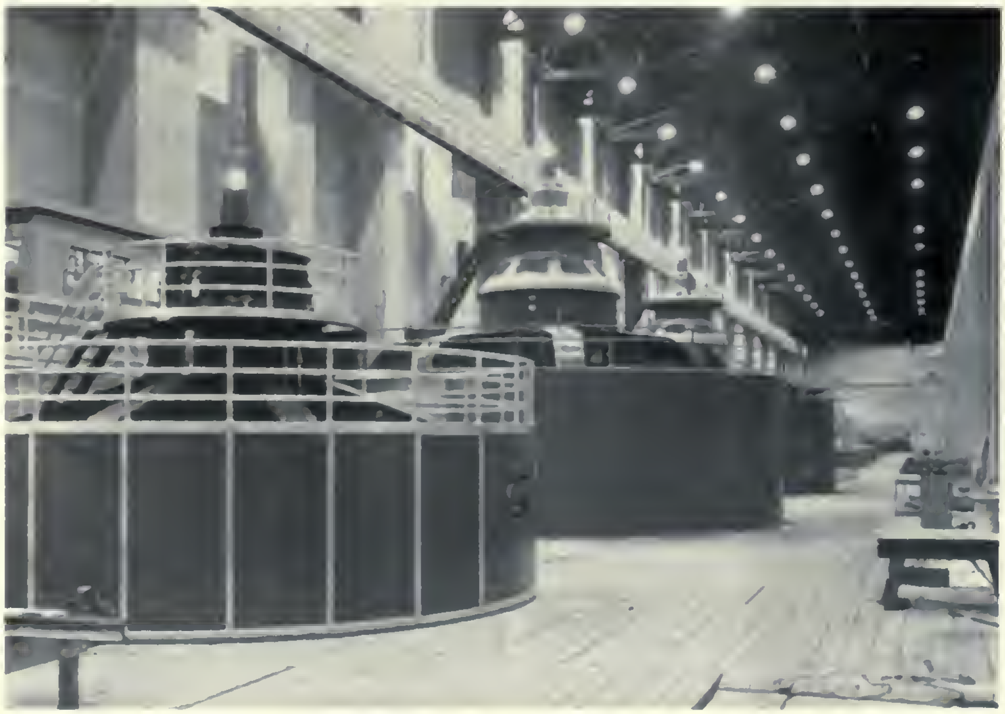
The first unit, A-7, was put under full load very quickly and from the date of starting, June 19 to December 31, 1939, generated 363,200,000 kilowatt-hours, an average load of 77,610 kilowatts and a load factor of 94.1 percent. The second unit, A-6, was operated in a similar manner and generated 207,760,000 kilowatt-hours between the date of starting, September 12 and December 31, 1939, an average load of 83,200 kilowatts or 0.8 percent over its rating of 82,500 kilowatts at 100 percent power factor. It is doubtful if any other hydroelectric units in the world have generated as much energy within the same length of time after first placing in service.

Of the energy generated by these two units during this period a large proportion of it has been used to compensate for a like quantity of energy furnished by the Edison Co. to the Pacific Gas & Electric Co., through its subsidiary, the San Joaquin Light & Power Corporation, from certain of the Edison Co.'s plants at the northern end of the Edison Co.'s system. Thus it has been that, by exchange, energy generated at Boulder power plant has been used in large amounts to relieve the power shortage in central and northern as well as in southern California.

The growth of the power load on Boulder power plant from the beginning of operation to the end of the year 1939 is shown by the following figures:

Total generation in kilowatt-hours

1936	123,993,000 (3 months)	1938	1,522,627,000
1937	1,180,143,000	1939	2,507,932,000



Arizona wing looking upstream, showing units A-6, A-7, and A-8 in operation; A-6 being painted

Arizona wing looking downstream, showing units A–6 and A–7 in operation. Fifty-five thousand kilovolt-ampere transformer being assembled in foreground

The peak load on the plant during the year 1939 was 589,200 kilowatts on November 29.

On January 1, 1940, the water surface elevation of Lake Mead was substantially the same as on January 1, 1939, being only 1.13 feet lower. During January, February, and March 1939, about 1,500,000 acre-feet of water were discharged for flood control purposes in anticipation of a large run-off from the watershed. The prospects for the 1940 run-off are such that it is improbable that much, if any, water will be evacuated from the reservoir for flood control purposes only; and, as of February 15, 1940, the storage in Lake Mead is 660,000 acre-feet greater than it was on the same date last year. The total storage on February 15, 1940, was 22,320,000 acre-feet. Even though the water supply and consequent power supply in the State of California should be deficient during the coming year as it was during the past year, and even if the inflow to Lake Mead should be below normal during the current year, as it was during the past year, there will be an abundance of water for all power requirements and for irrigation in the areas that receive water from Colorado River below the dam. The experience of the past year has furnished a very significant index of the wide spread of the benefits of the project.

The 1940 Census of Population

THE greatest fact-finding undertaking in the Nation's history is slated to take place in April, when the Sixteenth Decennial Census of the population of the United States will be conducted. The year 1940 brings the one hundred and fiftieth anniversary of census-taking in America, which began in 1790, as provided by article I, section 2, of the Constitution. This year's version of the census, however, is a far cry from the initial counting when, after a year and a half of work by the United States marshals who conducted the original enumeration, Congress was informed that the population of the country was somewhat under 4,000,000, the numbers being reported by States to provide a basis for apportioning membership in the House of Representatives.

This April, 120,000 census enumerators will visit 32,000,000 families, to enumerate the Nation's estimated 132,000,000 population, and to ask a series of questions designed to give the facts which will provide illuminating data on problems which have become particularly pressing in the last decade. Vital new statistical knowledge will be developed on education, mass migration, employment, unemployment, occupation, and wage and salary income, and by means of modern computing devices, preliminary summaries of the basic facts will be made available at an early date.

A count of the population and its distribution remains the basic purpose of the inquiry, but in line with the axiom, "New times, new problems," the schedule of questions covers a broader field than could have been foreseen in 1790.

There are separate columns for recording the answers to each of 33 questions on the general population schedule. Of these questions the average person is not likely to have to answer more than half. In addition, there are 16 columns of questions for a 5-percent sample of the population. The general questions on the population schedule are as follows:

For All Persons Enumerated

Location.

1. Street, avenue, road, etc.
2. House number (in cities and towns).

Household data.

3. Number of household in order of visitation (enumerator's record).
4. Home owned or rented.
5. Value of home, if owned, or monthly rental, if rented.
6. Does this household live on a farm?

Name.

7. Name of each person whose *usual place of residence* on April 1, 1940, was in this household.

Relation.

8. Relationship of this person to the head of the household, as wife, daughter, father, mother-in-law, grandson, lodger, lodger's wife, servant, hired hand, etc.

Personal description.

9. Sex—male or female.
10. Color or race.
11. Age at last birthday (age in months for children under 1 year old).
12. Marital status—single, married, widowed, or divorced.

Education.

13. Attended school or college any time since March 1, 1940?
14. Highest grade of school completed.

Place of birth.

15. (a) If born in the United States, give State, Territory, or possession.
    (b) If foreign born, give country in which birthplace was situated on January 1, 1937.

(*Continued on page 109*)

Parapet Wall on Agency Valley Dam

By HENRY L. LUMPEE, *Vale Project, Oregon*

AN outstanding example of rock masonry, the ancient art that moved civilization from caves and twig huts to stone temples and palaces, recently has been completed on the Vale project in Oregon by the Bureau of Reclamation in cooperation with the Civilian Conservation Corps.

The structure takes the form of a massive parapet wall 3½ feet high extending 1,782 feet along the upstream crest of the Agency Valley Dam across the North Fork of the Malheur River at Beulah. Its thickness is 18 inches, and at 16-foot intervals along its crest rise rectangular crowns of rock masonry 8 inches high and 4 feet in length, securing a bold and interesting outline.

The structure is composed of dark gray, very hard, basalt rock, of rough texture. Each rock used was hand cut, trimmed, and fitted in place with painstaking care. Each—and there are thousands—fits exactly right. The stones are mortared together with natural color cement pointed by half-round ⅝-inch beads. Occasionally throughout the wall appear lighter gray rocks. These, combined with the lines and color of the finely beaded joints and the dark of the mass of the wall rising above the rock riprap of the upstream and downstream slopes of the dam, offer an arresting color combination. Undoubtedly it is outclassed by few if any similar structures in fine appearance and careful workmanship.

The structure was built by C. C. C. enrollees attached to Camp BR–45, Company 551, Vale, working from a spike camp at Beulah. The average size of the crew was 49 enrollees, including a leader and three assistant leaders, supervised by a spike camp superintendent, one stone mason, and two subforemen. A nearly complete change in enrollee personnel occurred six times during construction.

Excavation for the foundation was carried on with pick and shovel to a depth and width of 3 feet. Generally speaking, the entire excavation was completed before laying of rock was begun.

Stone was secured from a quarry developed for the purpose approximately one-half mile distant from the east abutment of the dam. The quarry appears in the center middle distance of the comprehensive photograph of the dam accompanying this article. Small rocks were pried loose by crowbars and picks. Other rock excavation was accomplished by an RD–7 Caterpillar diesel tractor. Boulders were moved by a cable attached to this machine. No dynamite was used. Six enrollees were on duty at the quarry.

The selected stone was hauled to the construction site in dump trucks and stone boats. The trucks hauled the small rocks and drew the stone boats loaded with larger stones. A Cletrac 20-horsepower gasoline tractor also was used to haul stone boats, which were constructed of ¼-inch steel sheets and were 8 feet long by 6 feet wide. Three enrollees loaded the stone by hand; upon arrival at the dam it was delivered at points where needed.

The rocks placed in the parapet wall were shaped by hammer and chisel. All enrollees doing this work wore goggles to protect their eyes from flying stone fragments. A cement and sand mortar was used to bind the stone together. Cement was shipped in carload lots from Lime, Oreg., to Juntura, in the same State, and there hauled by truck a distance of 15 miles to Beulah. The sand used was obtained from the Government pipe plant near Nyssa, Oreg. It is called the Snake River sand and was hauled a distance of 102 miles by dump trucks to the work site.

Throughout the job from 100 to 200 feet of wall were under construction at a time. The great majority of the enrollees at the spike camp were given an opportunity to participate in the laying of the rock; however, the finishing top rock and the crowns were placed by members of the crew who had shown the greatest ability in stone masonry. Top rock and rock for crowns were carefully shaped on all six sides before placement.

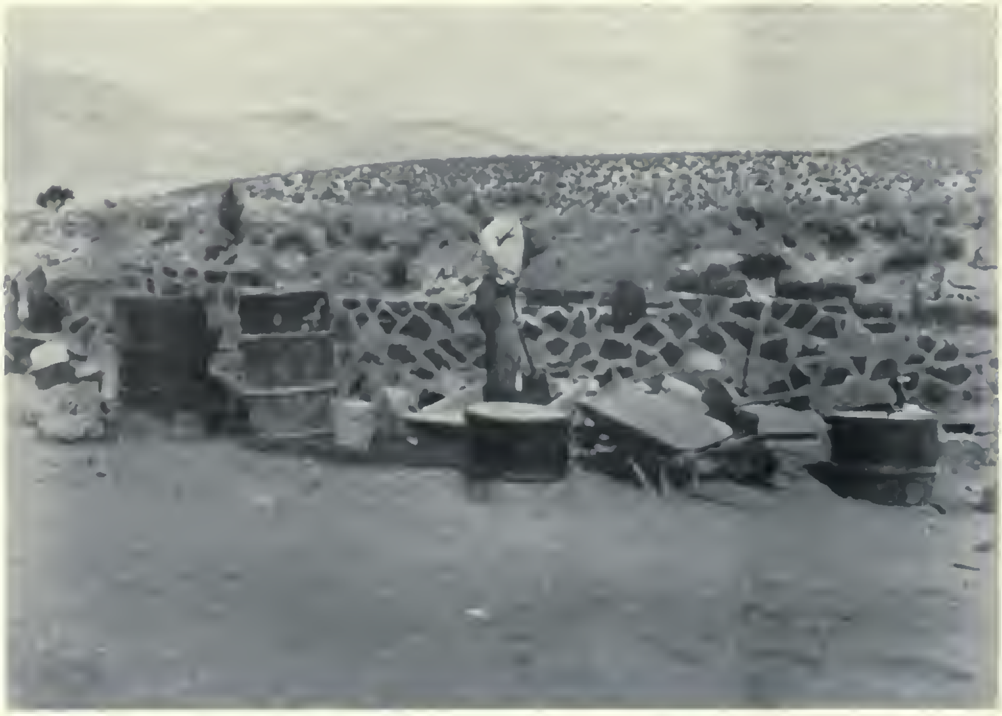
Rains stained portions of the wall with running cement. The stains were afterwards removed by use of a muriatic acid wash, and the joints pointed, as heretofore mentioned, with half-round beads of natural color mortar.

During freezing weather, construction was carried on under a canvas wall-tent 100 feet long and 12 feet wide. The tent was set up over the work in progress and the mortar mixed, placed, and allowed to dry within its protection. The tent was heated by large wood-burning stoves. Incidentally fuel was driftwood salvaged by the enrollees from Agency Valley Reservoir.

The engineering staff of the project office at Vale gave lines and grades, blue tops, and alinement points, for the work as needed. Steel wires and chalk lines stretched to grade and alinement guided the construction.

Paralleling the parapet wall and 30 feet from it along the roadway on the crest of the dam a small curb wall, 1 foot in height and width, was constructed after completion of the parapet wall. Construction methods and materials were exactly like those employed in building the larger parapet wall. The curb wall, however, has no crowns.

Approximately 200 CCC enrollees received



CCC enrollees constructing top course of parapet wall

Completed parapet and curb walls constructed by CCC enrollees, looking east from west abutment. Rock quarry in background

training in rock masonry while the work on the parapet and curb walls was in progress, and as a result at least a few of them may be expected to find employment in the rock masonry trade.

Total man-days expended on the work amounted to 13,330. Cost in CCC funds allotted to the Vale project was $15,388.58, of which $1,866.77 was for superintendence and accounts. Work was begun in April 1938, and completed in November 1939.

The walls were built under the direction of C. C. Ketchum, Regional Director of the Vale project, and Robert E. Hill, superintendent of Camp BR-45. George W. Baker and Carlton Meredith for different periods each acted as superintendent of the spike camp at Beulah, and Howard Featherston was the stone mason. James McDonald and John P. Cleary were employed as subforemen.

Irish Cobbler Potatoes on the Grand Valley Project

By **H. D. FINCH,** *Mesa County Extension Agent*

POTATOES were developed as an industry on the Grand Valley project in Colorado in the early twenties to hit an early market ahead of any midwestern producing sections. Now from 2,000 to 3,000 acres are grown annually and are marketed beginning in July.

Outstanding among the accomplishments of the settlers of this project are the raising of a single variety of potatoes for the district, the establishment of seed plots, control of diseases, and the marketing program.

In the early twenties many varieties were grown, including Downings, Cobblers, Triumps, and others. But it soon became apparent that the Irish Cobbler was the best variety for the project. Consequently, the only variety grown and marketed in carlots today is the Irish Cobbler. This makes it possible to conduct a seed-improvement program on this variety and to develop a uniform market for the potatoes. In time as new varieties are evolved, there may be discovered some other variety which will prove better. Tests are being run each year for comparisons in yield and quality but up to the present time none has excelled the Irish Cobbler.

From the start of potato growing on the project it was recognized that a seed-improvement program was necessary. Tests with certified northern-grown seed proved helpful in increasing yields. The seed plot was introduced and recommended to all growers. Certified seed potatoes were planted on a small plot on each farm. The potatoes harvested from the plot were placed in a storage cellar on the farm to be used the following year as seed in commercial planting. Now over 90 percent of the commercial potato growers on the project use seed plots. In this way, our commercial crop is just 1 year away from certified seed.

Diseases that must be controlled in growing potatoes on this project are Psyliid, Bacterial Wilt, Fusarium Wilt, Black Leg, and Rhizoctonia. Psyllids were discovered in the late twenties. In place of 1,000 cars of potatoes being shipped from this valley, only two cars were shipped in 1927. This was a complete shut-down from an unknown cause, though the trouble had first appeared in the seed plots in 1926.

In 1928 Richards of Utah discovered an insect, named "Psyllid." This small, flat, leaflike insect found on the underside of the leaves was very hard to see because it was the same color as the leaves and did not move. In about 12 days a dozen of these insects would completely kill a plant. The next year farmers put out experiments and found that lime-sulphur spray applied at the proper time during the season gave complete control of this insect. Since that year there has never been any appreciable damage from Psyllid.

Bacterial Wilt is the most serious potato trouble now known to us. It is serious because control is so difficult. The Grand Valley, however, has succeeded thus far in keeping it out of the area by keeping out seed containing the disease insofar as this is possible.

Bacterial Wilt, locally known as "zip" is caused by the presence of two or more bacterial organisms. The Bacterial Wilt organism alone will not cause trouble but when it is associated with Fusarium, for instance, or other specific organisms, break-down occurs. This breakdown appears in a ring about three-eighths of an inch inside the skin. A soft rot follows either outside or inside from this ring. The break-down is so rapid that in 2 or 3 days juice from the potatoes drips from the sack. Control thus far is in the experimental stage and sanitary precautions are being advised in the matter of seed selection, seed treatment, and other cultural practices.

Each year Fusarium, Black Leg, and Rhizoctonia appear in small infestations but have never become serious because of the protection afforded by our seed plot program. These diseases can be controlled by proper seed selection and seed treatment.

The Cobblers are marketed in carlot quantities beginning just after the Fourth of July. Two-thirds of the crop are marketed through a cooperative association, the Fruita Potato Growers Association. This association markets the potatoes through the Colorado Potato Exchange, a sales cooperative made up of local grower's associations.

New Interior Department Officials

Alvin J. Wirtz, Under Secretary of the Interior

Alfred Florian Beiter, Assistant to the Secretary of the Interior

ALVIN J. WIRTZ, whose appointment as Under Secretary of the Interior on January 2, 1940, was announced by Secretary of the Interior Harold L. Ickes, was formerly associated with the law firm of Powell, Wirtz, Rauhut & Gideon, of Austin, Tex. Born May 24, 1888, at Columbus, Tex., his early education was obtained in that city. He received the bachelor of laws degree in 1910 from the University of Texas and practiced law successively in Columbus, Eagle Lake, Seguin, and Austin (all in Texas) until the date of his present appointment.

Mr. Wirtz comes to the Interior Department with a reputation as an outstanding and able lawyer and a Nation-wide authority on the subjects of reclamation, irrigation, flood control, oil, and water power.

To Under Secretary Wirtz has been assigned jurisdiction over the National Park Service, Bureau of Reclamation, Bonneville project, Bureau of Biological Survey, Bureau of Fisheries, Grazing Service, Bituminous Coal Division, and the United States Board of Geographic Names.

Secretary Ickes has expressed his personal pleasure at the appointment by President Roosevelt of Alvin J. Wirtz, and states that "his liberal outlook and years of intimate association with activities in Texas, designed to conserve the natural resources of that area, fully qualify him for such a high post in this Department."

SECRETARY HAROLD L. ICKES announced on January 24 the appointment of Alfred F. Beiter of New York as Assistant to the Secretary of the Interior. Until his new assignment in Interior, Mr. Beiter served as Special Assistant to the Administrator of Public Works. He is a former Member of Congress, serving in the House of Representatives for 6 years, during which period he took an active interest in reclamation, conservation, and public-works legislation.

The Secretary's new assistant was born in Clarence, N. Y., July 7, 1893, and attended the Williamsville High School and Niagara University. He was elected supervisor of the town of Amherst, N. Y., in 1929 and was reelected to the same position in 1931. In 1932 he was elected to the Seventy-third Congress and subsequently was reelected to the Seventy-fourth and Seventy-fifth Congresses.

Boulder Transmission Line

THE city of Los Angeles has completed construction of its third transmission line from Los Angeles to Silver Lake, near Baker, Calif., and at the close of February had erected 80 percent of the steel towers between Silver Lake and Boulder Dam.

Klamath Building Operations

CONSIDERABLE building at Klamath Falls, Oreg., headquarters of the Klamath project, is in progress, permits totaling more than $70,000 having been issued during a recent month.

The 1940 Census

(*Continued from page 105*)

(c) Distinguish Canada-French from Canada-English, and Irish Free State (Eire) from Northern Ireland.

Citizenship.

16. Citizenship of the foreign born.

Residence April 1, 1935.

17. In what city, town, or village having 2,500 or more inhabitants did this person live on April 1, 1935?
18. In what county?
19. In what State, Territory, or foreign country?
20. On a farm? (Yes or No.)

For Persons 14 Years Old and Over

Employment status:

21. Was this person at work for pay or profit in private or nonemergency Government work during week of March 24–30? (Yes or No.)
22. If not, was he at work on, or assigned to, public emergency work (WPA, NYA, CCC, etc.) during week of March 24–30? (Yes or No.)
23. If neither at work nor assigned to public emergency work, was this person seeking work? (Yes or No.)
24. If not seeking work or at work, did he have a job, business, etc? (Yes or No.)
25. If not in any of the previous employment status groups, indicate whether engaged in home housework, in school, unable to work, or other?
26. If at private or nonemergency Government work, number of hours worked during week of March 24–30, 1940.
27. If seeking work or assigned to public emergency work, duration of unemployment up to March 30, 1940—in weeks.
28. Present or last occupation, trade, profession, or particular kind of work, as frame spinner, salesman, laborer, rivet heater, music teacher, or, for those with no previous work experience, new worker.
29. Present or last industry or business, as cotton mill, retail grocery, farm, shipyard, public school.
30. Class of worker (present or last work), as wage or salary worker in private work; wage or salary worker in Government work; employer; working on own account; unpaid family worker.
31. Number of weeks worked in 1939 (equivalent full-time weeks).
32. Amount of money wages or salary received (including commissions) during 12 months ending December 31, 1939.
33. Did this person receive income of $50 or more from sources other than money wages or salary, during 12 months ending December 31, 1939? (Yes or No.)

To be enumerated with the household are persons temporarily absent, such as students away at college. "Be sure to include children under 1 year of age," the enumerator is reminded by a notation on the schedule, for it has been found that the person reporting often forgets "the baby."

The question as to highest grade of school completed is new on the schedule, replacing a former query on illiteracy, which has dwindled to insignificant proportions statistically.

Also being asked for the first time are the questions on place of residence 5 years ago, which are designed to measure internal migration, such as movements from dust bowl areas, etc.

In reporting on occupation, industry, and class of worker, those with a job will specify their present status. Those seeking work will report details of their last employment, while a separate category entitled "new worker" has been established, in the words of Secretary of Commerce Hopkins, "to obtain a picture of the number of young people who have finished their schooling in recent years but have been unable to obtain work and thus acquire an occupation."

The income questions are an important addition to the schedule. The answers, when tabulated, will provide valuable information on distribution of purchasing power.

Only one in 20 persons will be asked the following additional questions, to obtain statistical data on a sample basis, concerning subjects on which information as to trends often is requested of the Census Bureau:

For All Persons

Place of birth of father and mother (see instructions for Question 15).

36. Father.
37. Mother.

Mother tongue.

38. Language spoken in home in earliest childhood.

Veterans.

39. Is this person a veteran of the United States military forces; or the wife, widow, or under-18-year-old child of a veteran?
40. If child, is veteran-father dead? (Yes or No.)
41. War or military service.

For Persons 14 Years Old and Over

Social security.

42. Does this person have a Federal Social Security number? (Yes or No.)
43. Were deductions for Federal Old-Age Insurance or Railroad Retirement made from this person's wages or salary in 1939? (Yes or No.)
44. If so, were deductions made from (1) all, (2) one-half or more, (3) part, but less than half, of wages or salary?

Usual occupation, industry, and class of worker

45. Usual occupation.
46. Usual industry.
47. Usual class of worker.

For All Women Who Are or Have Been Married

48. Has this woman been married more than once? (Yes or No.)
49. Age at first marriage.
50. Number of children ever born, not including stillbirths.

The supplementary query on usual occupation, industry, and class of worker is distinct from the general question on present or last occupation, industry, and class of worker. It is designed to get information on the number of persons who may be working out of their usual trade or profession.

In all, the average person will spend about 15 minutes answering questions of the enumerator in the Population Census this April.

Already under way, since January, are the censuses of business, manufactures, and mines and quarries. To be conducted in April, at the same time the census of population is taken, are the censuses of housing, agriculture, and drainage and irrigation.

Elephant Butte Power

THE generation of power is a new phase of the Rio Grande project development. Elephant Butte Dam was completed by the Bureau of Reclamation in 1916 and has been in continuous operation for irrigation ever since. It has not been possible to develop power because the water had to be stored for irrigation. Water released to accommodate the demand for irrigation would provide only seasonal or dump power for which there was no market.

By the construction of Caballo Dam downstream a regulating reservoir has been provided which will allow a power plant at Elephant Butte to operate continuously, thus providing firm power throughout the entire year, while the recaptured water can be released from Caballo Reservoir to suit irrigation requirements. The power plant at Elephant Butte Dam will have a total installed capacity of 27,000 kilovolt-amperes.

Secretary of the Interior Harold L. Ickes recently made award of a contract to the Aluminum Co. of America for the purchase of an aluminum conductor and accessories for the 62-mile transmission line from Elephant Butte Dam to Las Cruces, N. Mex., which will put electricity generated at the plant on farms and homes of the Rio Grande project area.

Boulder Visitors

VISITORS to the Boulder Dam power plant during the month of February numbered 13,639, representing an excess of 1,209 over the number of visitors in January.

Potato Testing on Uncompahgre Project

By J. P. HARTMAN, *Montrose County Extension Agent*

"ZIP" is a local name given to a bacterial disease of potatoes. More universally known as bacterial wilt or bacterial ring-rot, it is still "zip" to our local spud growers, shippers, and inspection service. The first severe losses from this disease were in 1937, when it was given its name. At harvest time growers noticed rotten or decayed tubers under the vines that had wilted and died during the growing season. Shippers realized its importance when some of their cars lost grade in shipping. A few of their worst cars had juice running out of them when they arrived at their destination; consequently, severe losses occurred and the disease acquired the truly characteristic name, "zip."

Immediate steps were taken by the county agent, growers, and shippers to secure assistance from the experiment station of the Colorado Agricultural College in helping solve the problem. C. H. Metzher and W. A. Kruetzer responded spending considerable time visiting potato fields, examining vine and tubers, and discussing the problem with farmers. Numerous samples were sent to the college and Mr. Kruetzer and Eddie Bodine experimented with them during the winter of 1937–38, under greenhouse conditions. They were able to isolate the bacteria that caused the disease and further discovered that the same disease was causing losses and poor quality potatoes in nearly all commercial potato-growing areas in the United States. Some potatoes are shipped in here in the late spring and early summer and we find the disease in these potatoes the same as our own. We were able to make several suggestions to growers in 1938, from the observations of the disease in 1937, and whether or not these suggestions were used by growers the losses for 1938 were materially less.

For 1938, we decided to plant several plots to test the value of treating and the different methods of disinfecting seed potatoes, as well as to learn more about field conditions of bacterial wilt in infected seed tubers and the inoculation of clean seed with the wilt vines. Varietal tests as well as comparisons of certified and uncertified seed were made. The test plots were drawn up and worked out cooperatively between the experiment station of the State college, the Extension Service, local shipping associations, and potato growers.

One of the first tests was planting certified disease-free seed in a field almost 100 percent infected the previous year. In addition to planting the certified seed, the farmer replanted some of his own seed potatoes in the field. The potato vines of his own seed wilted and 95 percent died with "zip" during July, but not a single plant of the certified seed was affected. At digging time the certified seed produced 2,900 pounds of No. 1 potatoes for each 100 pounds of seed planted. His own seed yielded 325 pounds for 100 pounds of seed planted. A lot of each was put in storage and on November 29, 93.61 percent of his own seed showed tuber symptoms of the disease and only 1.76 percent of the certified seed showed any discoloration. A similar test in 1939, allowed us to conclude that the disease is not transmitted or carried over in the soil and that our main casual agency is in the seed planted.

In 1938, a 3-acre test plot on H. B. Coffman's farm at Olathe, and a similar one in 1939, on Torrey Brother's farm at Olathe, gave us the following conclusions:

1. Seed treatment increased stand and yield and to a certain extent held the disease in check.

The following seed treatments killed germination:

Ceresan (1 ounce to 1 gallon water) wet dip.
Cuprocide "54" as dust.
Semesan Jr. as dust.
Ceresan lime 1–20 as dust.

The following seed treatments indicated no improvement over no treatment:

Sulfur as dust.
Cuprocide "54" lime 1–50 as dust.
Lime as dust.
Semesan Bel wet dip before cutting.

Semesan Bel dip after cutting has given very good results. Acid mercury dip both before and after cutting gave favorable results but not as good as the Semesan Bel. Another treatment of dust known as Shattucks gave good results in 1939.

2. The cutting knife is a serious agency of spreading the disease. Yields were reduced over 50 percent by alternating cutting of diseased and good tubers. The disease may be spread to the fifth cut. In cutting seed stock with infected tubers sterilization of the cutting knife is important.

3. Certified seed showed increased yields over seed plot or common seed stocks and had no disease in it.

4. Our tests to date show some increase in spreading disease by the use of a picker planter. This, however, has not been as serious as might be expected.

5. At temperatures of 75° to 80° the disease is very active. Generally at temperatures of less than 50° as in storage cellars the disease is inactive or dormant. We found that warming up seed at 70° or better for a week or 10 days and then sorting the seed and eliminating the dormant and diseased tubers, materially increased stand and yield of potatoes.

6. Overirrigation causes the disease to develop more rapidly.

7. To date our tests show the disease spread only through the seed and from diseased seed to good seed by cutting and planting. We cannot prove that insects carry the wilt from plant to plant but unsprayed fields generally have more disease than fields where psyllid and flea beetle are controlled.

It has been difficult to get farmers generally to renew their seed stock with certified seed. But farmer field tours of our various test plots, publicity of results, talks at Potato Grower's meetings and other information to farmers has resulted in general control of the disease and not a carload shipment has been lost during the past 2 years.

Colorado River Film Strip Available

A film strip, standard size, with lecture, on the subject Conquest of the Colorado, is now available for purchase from the Bureau at 50 cents a copy. Fifty-one pictures are shown descriptive of the treacherous Colorado River, the building of Boulder, Parker, and Imperial Dams, and of the All-American Canal. Please accompany your purchase request with check or money-order for 50 cents made payable to the Bureau of Reclamation, and addressed to the Commissioner, Bureau of Reclamation, Department of the Interior, Washington, D. C.

Industrial Development on the Carlsbad Project

A GREAT deal of interest and activity is reported in the oil fields north and east of the Carlsbad project. Several new producers have been drilled. The extension of a spur railroad from Loving to the Union Potash mine is being continued with a force of 175 men.

Carlsbad Improvements

CONSTRUCTION of the high school building on the Carlsbad project with PWA labor was approximately 85 percent completed early in March. A municipal program consisting of the construction of concrete sidewalks and curbs with WPA labor has been commenced, and considerable progress has been made. A WPA project consisting of street improvements is also under way at this time.

The Project of Good Venture

A Story of the Adopted Plan for Furnishing Concrete Aggregates for Shasta Dam

By HARRY S. RIDDELL, *Assistant Engineer*

MAJ. PIERSON B. READING, a pioneer settler of the West, of course never had heard or dreamed of Shasta Dam when on February 7, 1844, he wrote from Monterey, then the Mexican capital of California, to his brother as follows:

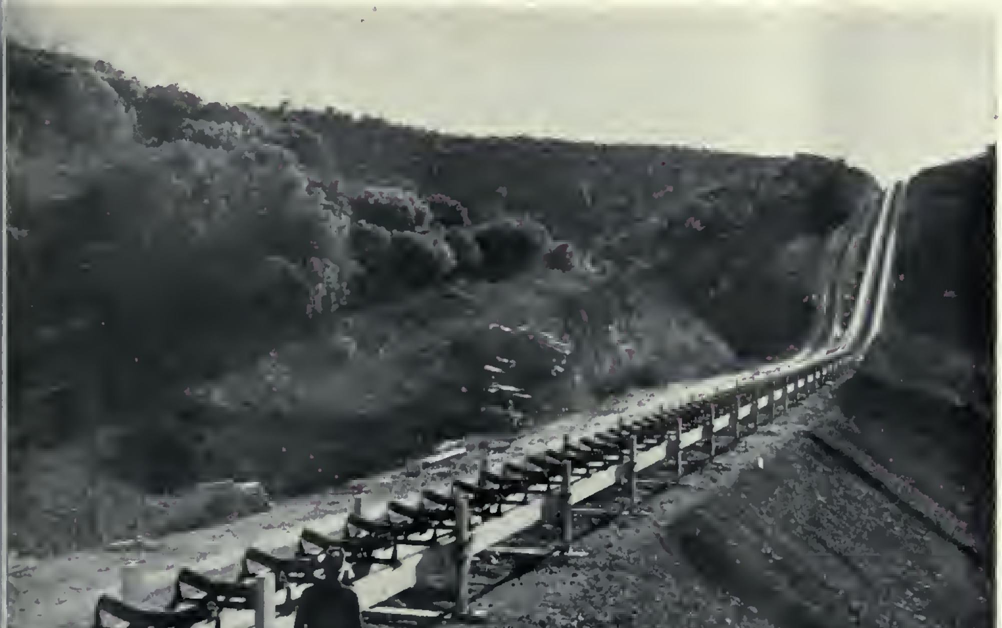
"I have received from the Government a large tract of land as a grant. The title is good and secures the land to me forever. The tract is in length five leagues, on the bank of the Sacramento River, and one league deep. A more beautiful land I never saw."

Naturally no one could foresee that a boulder-strewn flat at a bend of the river in the northeast corner of Major Reading's famous 26,632-acre Rancho San Buenaventura—the Ranch of Good Venture—would, almost a century later, supply the aggregates for construction of the world's second largest concrete dam. Today bramble bushes and scrub oak are being removed from the flat and a huge walking dragline is stripping the overburden in preparation for one of the largest gravel processing jobs ever undertaken. The tract is to furnish 7,600,000 tons of gravel and 2,800,000 tons of sand for the manufacture of concrete for Shasta Dam, major feature of the Central Valley project. The aggregate contract is separate from the general construction contract on the dam.

Investigations Begun

The aggregate investigations, begun in 1936, covered more than 50 gravel beds and rock deposits in Shasta, Tehama, Siskiyou, Butte, and Glenn Counties of California. The work involved the digging of about 450 exploratory pits, taking hundreds of drill samples, and testing them in Bureau of Reclamation laboratories. The area is in that part of California where there has been considerable gold mining, including gravel bed dredging, ever since Major Reading's time. The United States, having acquired the gravel rights but no fee title to the selected deposit, has no interest in the fine particles of gold found in the gravel. However, the property owner and aggregate contractor are contemplating the installation of gold recovery equipment in connection with the gravel processing.

Section of aggregate conveyor under construction, showing trough rollers in place ready for belt



As a result of the exhaustive investigations, the choice was narrowed to two sources—the North Kutras tract and the Hatch tract—and bidders were asked to submit offers for preparation of aggregates from one or both of the alternative deposits, either of which contains gravel and sand in adequate quantity and quality. The North Kutras tract is located 12 miles downstream from the dam site, just east of Redding, the city named after Major Reading but designated Redding by a map maker who couldn't spell. The Hatch tract is located on the Sacramento River 28 miles downstream from the dam site just south of Bloody Island which marked the boundary of the old Rancho San Buenaventura.

Five bids were received, three for use of the North Kutras tract and two for use of the Hatch tract. The lowest was that of the Columbia Construction Co., Inc., of Oakland, asking $4,413,520 for preparation of 10,400,000 tons of aggregates from the North Kutras tract in the original Reading grant. The unit price of the bid was 41.88 cents a ton. A contract was awarded to Columbia on August 1, 1939. Washed and graded aggregates are to be furnished in five sizes—one of sand and four of gravel. The largest gravel will be 3- to 6-inch, the next 1½- to 3-inch, then ¾- to 1½-inch, and the smallest 3/16- to ¾-inch.

Installation of Conveyor System

Contemplating delivery of the aggregates by railroad, the original specifications called for construction of a 4-mile spur from the gravel deposit to a proposed interchange yard at Middle Creek on the main line of the Southern Pacific north of Redding. The Columbia Co. subsequently proposed as an alternative the delivery of aggregates direct to Pacific Constructors, Inc., the general contractor at Shasta Dam, by means of a long series of belt conveyors from the gravel deposit at Redding to Pacific's hoppers at Coram just downstream from the dam site. Accordingly, under an agreement reached between the Bureau of Reclamation, the Columbia Co., and Pacific Constructors, change orders were issued in October, providing for construction of the conveyor system by Columbia and transportation of the aggregate to Coram.

The belt system, being rushed to completion,

Aggregate conveyor between Redding and Coram, looking down long flight toward Sacramento River

Looking out of recovery tunnel under raw storage pile toward mill building, during first test run

will be the longest ever constructed. Instead of following the winding canyon, like the railroad, it extends over the hills almost on a bee-line from Redding to Coram, a distance of 9.6 miles, in 26 flights, crossing the Sacramento River twice and passing over United States Highway No. 99, the main line of the Southern Pacific, five county roads, and four creeks. The right-of-way was obtained by the Bureau of Reclamation. An additional mile-long belt conveyor is being built by Pacific Constructors to transport the aggregate from the Coram hoppers to nearby stock piles and thence to the concrete-mixing plant at the dam site.

Most of the framework for the conveyors is of wood construction. One canyon crossing requires 90-foot steel bents. Each flight will be operated by a 200-horsepower motor except the last four. These are located on the east slope of the Sacramento River Canyon on a down grade as steep as 25 percent. These four flights will be equipped with motor generators which can utilize the kinetic energy of the loaded belt to generate power to help pull the aggregates over the hill on preceding flights. The conveyor is to be illuminated by sodium vapor lamps for night operation.

A contract for furnishing 16,000 trough and return belt idlers, or rollers, was awarded by Columbia to the Chain Belt Co. of Milwaukee, Wis. About 18 miles of steel tubing, 11 miles of steel shafting, 10½ miles of angle iron, 50,500 malleable castings and 83,000 antifriction roller bearings are required for the idlers. A contract for manufacture of more than 20 miles of 36-inch 6-ply belting was awarded the Goodyear Tire & Rubber Co. of Akron, Ohio. Almost 1,000,000 pounds of rubber and more than 1,000 bales of cotton are required for the belts in the world-record conveyor.

The estimated maximum daily aggregate requirement at Shasta Dam is to be 16,000 tons of gravel and 6,000 tons of sand when concrete placement reaches a peak, probably in 1942. The capacity of the belt system is to be 1,100 tons of material an hour while conveying at a speed of 550 feet a minute. Blended sand and the different sizes of gravel will be transported, one type at a time. Material will be in transit on the conveyor 1 hour and 40 minutes from Redding to Coram.

Major Reading's journal of 1844 mentioned that grizzly bears were so numerous they made well-worn trails through the tract. The closest thing to a monster on the tract today is Columbia's gigantic dragline that walks like a duck on crutches and reaches out a 140-foot boom to pick up 11 tons of material at a scoop. This 8-yard Monighan, with the help of another 5-yard Monighan working as a stripper, feeds pit material into a skid-mounted vibrator hopper at the end of a pendulum belt conveyor that discharges to a raw stock pile of 8,200 tons live storage near the new washing and screening plant. All oversize rock is put through a jaw crusher to reduce it to a maximum of 6 inches in raw storage.

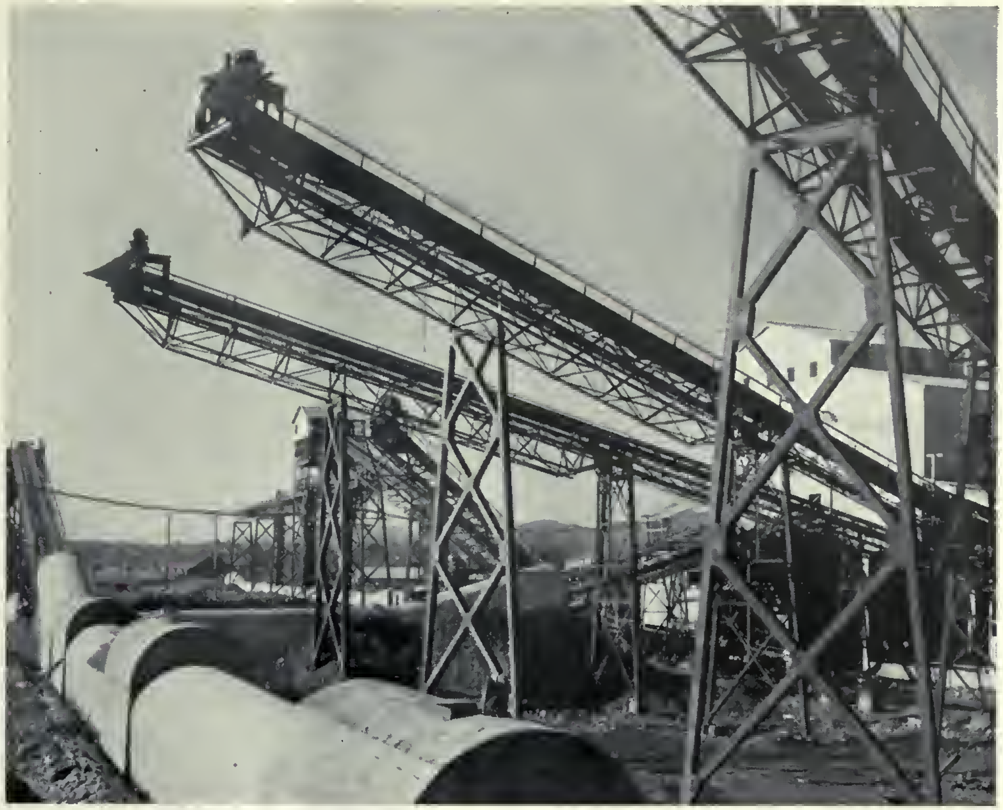
The raw stock is reclaimed by a 42-inch belt and delivered to a bank of four screens atop the main mill building where the material is washed by water sprays and all gravel greater than 3/16-inch is scalped off and delivered to a large scrubbing trommel. The coarse gravel leaving the trommel goes by 36-inch belt to another bank of classifying screens for grading into 3- to 6-inch, 1½- to 3-inch, ¾- to 1½-inch, and 3/16- to ¾-inch sizes, which in turn are distributed to separate 2,000-ton stock piles. Any of these sizes can be reclaimed and returned to a cone crusher for reduction to smaller sizes which may be deficient. Some of the pea gravel, 3/16- to ⅜-inch size, leaving the trommel can be screened out and diverted to a balance stock pile for subsequent delivery to a rod mill for processing into sand. This balance stock pile also can be built up of material from the cone crusher.

The less than 3/16-inch residue passing the first bank of screens at the top of the building is processed to make acceptable sand. It flows by gravity to a slug mill for differential grinding required by the specifications to eliminate certain deleterious shale and fines in the sand. The product of the slug mill flows to a 20-foot hydroseparator which eliminates a portion of the deleterious waste as overflow. The underflow from the hydroseparator goes to a rake classifier. The rakes of this classifier remove the coarse sand. The overflow goes to two successive rake classifiers which remove intermediate and fine sand respectively. The overflow of the third classifier is silt and is wasted. The manufactured sand produced by the rod mill flows to a smaller hydroseparator which washes out the fine dust and delivers the underflow to the same three rake classifiers for separation into coarse, intermediate, and fine sand.

The three sizes of processed sand are stored in separate 2,250-ton piles and subsequently reclaimed and combined in the required proportions by weight-controlled feeders which issue to a 30-inch belt discharging to the main blended sand stock pile of 30,000 tons live storage. The largest size sand can be returned from its separate pile to the rod mill for further reduction if necessary.

Classified gravels and blended sand are reclaimed from the main stock piles as needed by belts which pass over automatic scales and then discharge on the Redding-Coram conveyor which leads from the aggregate plant across the river and over the hills toward the dam site.

Work on the gravel plant was started in August with the building of wood-frame and concrete reclaim tunnels to underlie all stock piles. The elevated conveyors discharging to stock piles are supported on steel towers. The six-story mill building is of steel-frame construction. Machinery was installed and the first trial runs made in December. Processing of aggregate began in January and deliveries to Coram are scheduled to start this spring.



Closeup of overhead conveyors which will feed processed sand to stock piles overlying sand recovery tunnel

Aggregate processing plant, showing overhead conveyors, mill building, and recovery tunnels

Closeup of the six-story washing and screening mill, with sand and gravel conveyors in foreground

An estimated requirement of 5,800,000 barrels of cement for Shasta Dam is to be furnished under a contract held by The Permanente Corporation which has constructed a large manufacturing plant west of San Jose, Calif. The cement plant now is in operation and also is scheduled to begin deliveries to Coram this spring. The first concrete is expected to be placed in the base of Shasta Dam as soon as the seasonal high water of the Sacramento River subsides. The ultimate use of aggregates from the old "Ranch of Good Venture" will be in the major structure of a multiple-purpose reclamation project which might aptly be described as the "Project of Good Venture."

Belle Fourche Power

INTEREST in rural electrification on the Belle Fourche project is increasing, and plans now being formulated will mean power eventually for the greater portion of the project, as well as the irrigated areas south of Belle Fourche.

Yakima Sugar Beets

A TOTAL of 220,000 tons of sugar beets were processed at the Toppenish factory of the Utah-Idaho Sugar Co., Yakima project, during the season's run completed early in February. Returns to the growers, including benefit payments, are estimated at $2,282,600.

NOTES FOR CONTRACTORS

Specification No.	Project	Bids opened	Work of material	Low bidder		Bid	Terms	Contract awarded
				Name	Address			
1328-D	Boulder Canyon, Ariz.-Nev.	*1940* Feb. 20	443 type A anchor-jack assemblies and 173 type B anchor-jack assemblies for 13-foot diameter penstocks at Boulder Dam.	Arthur J. O'Leary & Son Co.	Chicago, Ill.	$6,590.00	Discount ½ percent	*1940* Feb. 28
1330-D	Central Valley, Calif.	Feb. 26	Fabricated pipe, fittings, and appurtenances for bypass and air-inlet piping for main unit penstocks at Shasta Dam.	Provo Foundry & Machine Co.	Provo, Utah	23,850.00	F.o.b. Coram, Calif., discount 1 percent.	Mar. 6
B-38,141-A	Columbia Basin, Wash.	Feb. 20	Steel reinforcement bars (2,100,000 pounds).	Bethlehem Steel Co.	San Francisco, Calif.	48,300.00	Discount ½ percent on 47 cents less.	Mar. 5
878	Boulder Canyon, Ariz.-Nev.	*1939* Nov. 16	Main and auxiliary control equipment, automatic oscillographs, battery distribution switchboard, auxiliary power control equipment and air circuit breakers.	Westinghouse Electric & Manufacturing Co.	Denver, Colo.	[1] 54,221.00 [3] 21,124.00	F.o.b. Boulder City do	Mar. 18 Do.
884	Yakima-Roza, Wash.	*1940* Jan. 26	Earthwork, canal lining and structures, stations 714+85 to 724, Yakima Ridge Canal, Wasteway No. 2, stations 0 to 57 and Yakima River dike.	J. A. Terteling & Sons	Boise, Idaho	98,870.00		Mar. 22
1335-D	Provo River, Utah	Mar. 11	Two 5- by 6-foot high pressure gates for outlet works at Deer Creek Dam.	Joshua Hendy Iron Works	San Francisco, Calif.	17,657.00		Mar. 19
1336-D	Colorado-Big Thompson, Colo.	Mar. 11	Weather stripping residences and duplex cottages at Shadow Mountain Camp.	Ideal Metal Weather Strip Co.	Boulder, Colo.	362.00		Do.

[1] Schedule 1.

[3] Schedule 3.

Improvements to Belle Fourche Dam

THE Belle Fourche Dam was one of the early major structures designed and built by the Reclamation Bureau. At the time of its completion in 1911 this was the largest earth dam in the world—122 feet high, 6,262 feet long, and containing 1,600,000 cubic yards.

Located on Owl Creek, 15 miles northeast of the city of Belle Fourche and 25 miles north of the Black Hills, the dam forms a reservoir with a capacity of 197,000 acre-feet live storage, 97-foot depth, and covers 8,000 acres. Water surface elevation varies from 2,975 at spillway level to 2,927, lowest outlet sill, leaving a dead storage depth of 49 feet. Water is obtained principally from the Belle Fourche River by diverting this stream into a supply canal 7 miles long, which cuts through the divide and empties into the Owl Creek Basin.

The dam has a 19-foot crest width at elevation 2,990. The upstream face slopes down to the highwater level at 1½ to 1; then 2 to 1 to a toe wall at elevation 2,920; and below this 5 to 1 to the creek bottom. The downstream face is on a 1.655:1 slope from the crest to elevation 2,960; then on a 2:1 slope to the creek bed. The 2:1 slope is broken at elevations 2,960 and 2,930 by berms 8 feet wide containing gutters for draining storm water from the slope. The dam is built of a material predominating in clay rolled in 6-inch layers, each of which was carefully sprinkled. The water side is faced with concrete blocks, size 5 x 6½ feet, 8 inches thick, precast at a gravel pit 6 miles south and hauled to the site by a narrow gage railroad.

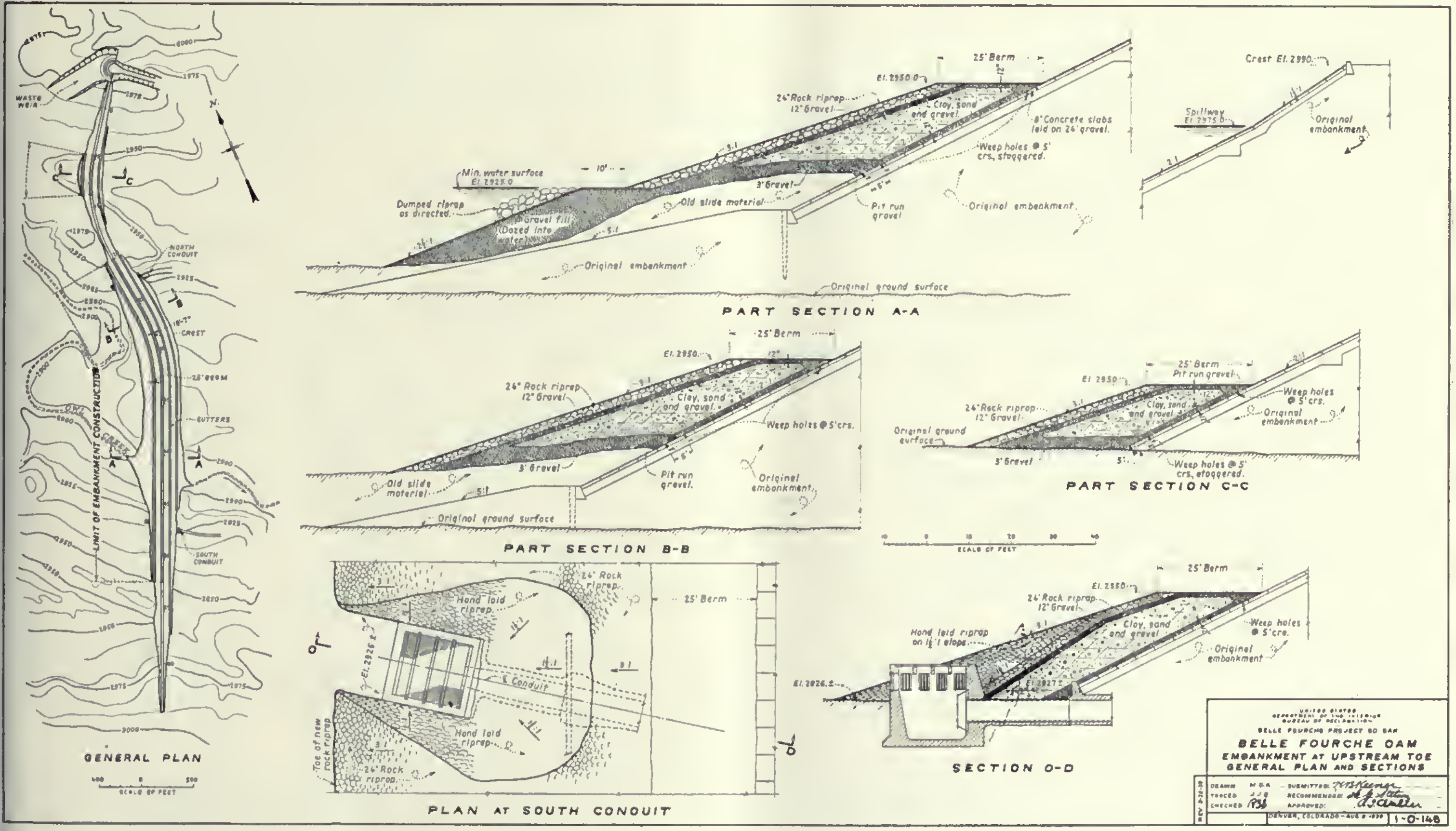
Placing rock

Two conduits through the dam provide for outlet of water into the North and South Canals. The flow is controlled by balanced valves placed at the upper end, and these are regulated from control houses at the outlet end of each conduit. Five hundred miles of distributing canals serve 61,000 acres of irrigable land, of which about two-thirds is being irrigated.

A spillway at the north end is 15 feet below the dam crest and consists of a semicircular weir 314 feet long to take care of heavy rains on the Owl Creek watershed of about 200 square miles. The last flow over the spillway was in May 1920, when a wet spell and full reservoir resulted in 21,000 acre-feet excess accumulation and spillway operated 13 days, the maximum head reaching 1.6 feet.

For the 20-year period ending in 1930 the Belle Fourche River flowed an average of 338,000 acre-feet per year, or about twice the quantity needed annually for irrigation, reaching a maximum of 571,000 acre-feet in 1929. For the next 9 years the average went down to 108,000 acre-feet and an all-time minimum of 68,385 acre-feet was recorded for 1939. During the twenties the least carry-over, on October 1, was 68,000 acre-feet except when the reservoir was drained in 1928 for mechanical repairs to the valves.

Storage deficiency created new problems not only in irrigation, but also in connection with reservoir draw-down and hydrostatic pressure within the dam. In 1931, the first year of shortage, the water surface was lowered 27 feet in 60 days, and on August 2 the upstream face of the dam slumped over a distance of 600 feet, extending up to elevation 2,962. Repairs required placing 63,000 cubic yards of earth and gravel fill, relaying 1,492



South crib and rock riprap

blocks and placing 280 cubic yards of concrete at a cost of $46,781.

Improvement of Dam Stability

Subsequently piezometer tubes were installed on the upstream side of the dam with tips at various elevations from 2,920 to 2,950 for the purpose of providing data for study of internal pressure. Since water shortage continued from year to year, and the limited supply was urgently needed for crops during the heat of summer, arrangements were made for improving dam stability so that all risk connected with rapid draw-down might be removed.

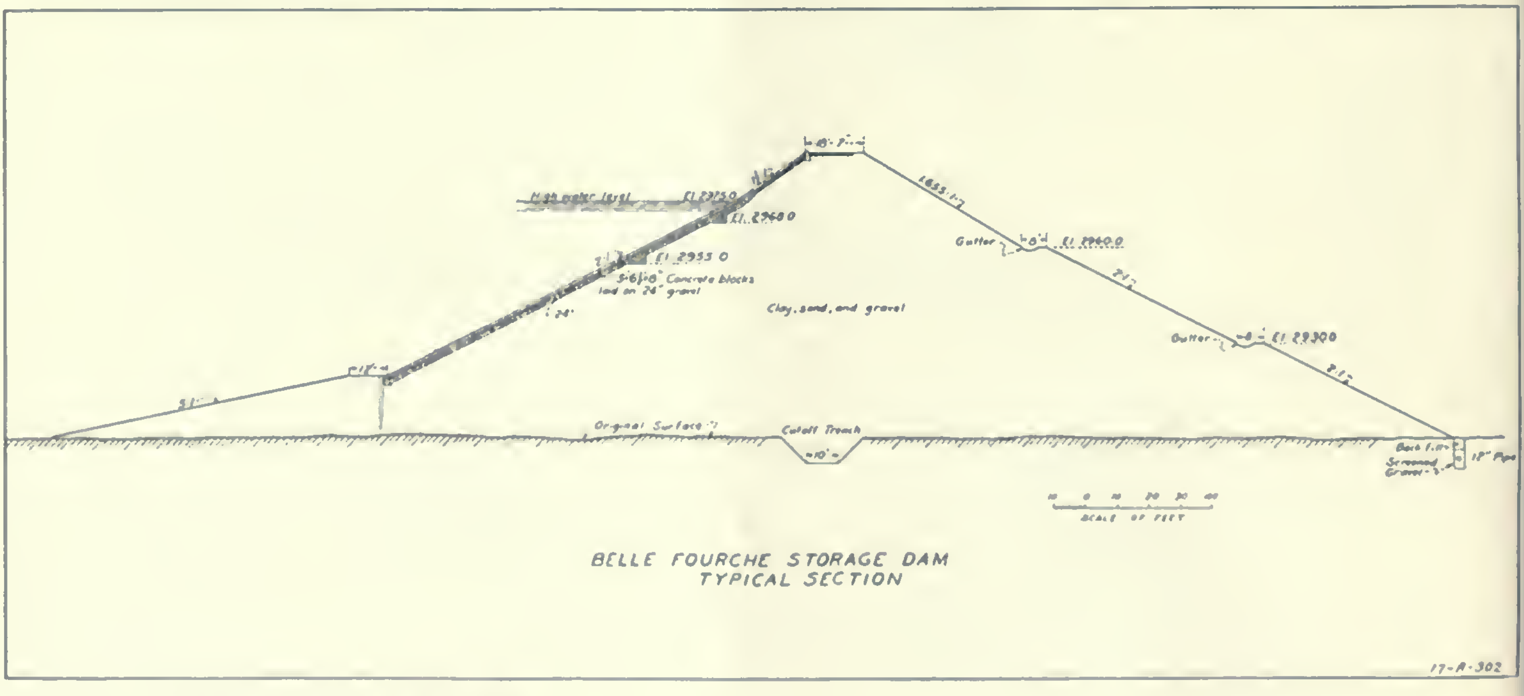
The plans called for a reinforcement fill that in effect would change the slope on the water side below elevation 2,950 to 3½ to 1. Time was a controlling feature in the undertaking since the situation as to water supply demanded that little or no run-off be permitted to escape down the river. For the year 1939 storage reached a maximum of 64,500 acre-feet early in May, and it became evident that the reservoir would be empty in September, presenting an opportune time for carrying on the work during the fall months.

The nearest gravel was 5 miles from the dam and suitable rock was available in the Black Hills, 28 to 40 miles away. It was therefore considered economical to use the local clay earth for the body of the fill and to provide drainage from the dam through a 3-foot gravel base and a 12-inch gravel lining on sides and top. Rock riprap 24 inches thick, dumped with minimum of hand placement, was to protect the new fill against wave action, taking the place of the concrete slabs, which were not disturbed on the original dam section. Weep holes, however, were drilled on 5-foot centers through the concrete to give drainage from within the dam embankment.

Bids were opened on September 6 under Specifications No. 873 calling for 58,000 cubic yards earth fill, 72,000 cubic yards of gravel, 21,000 cubic yards rock riprap and drilling 6,100 linear feet of weep holes. The Northwestern Engineering Co., of Rapid City, S. Dak., was the low bidder at $119,930. Procedure was expedited and the contractor commenced drilling operations September 30, gravel hauling began October 9, rock hauling got under way October 13, and placing of earth fill commenced October 23. The entire job was completed December 17, well within the time allowed. The contract called for a low water level of 2,925, which was reached early in October, and with irrigation in progress it was possible to bring the reservoir down to 2,924.0 by October 20. Holes were opened through the crib walls to lower the water 3 feet below the normal empty level.

The fill was rolled in 6-inch layers as required by the specifications, and moisture con-

(*Continued on page 123*)



BELLE FOURCHE STORAGE DAM
TYPICAL SECTION

Arizona Desert

Home on a reclamation project

An irrigated farm

Farm and Home Opportunities

[See NOTE at close of listings, next page]

Shoshone Project, Wyoming

Description	Price and owner	Remarks
45.13 irrigable acres. Farm unit K, lot 70, T. 55 N., R. 98 W., 6th P. M., Wyoming; 1¼ miles east of Powell, Wyo.; 31.13 acres class 4; 14 acres class 5.	$6,000; cash $3,000, balance over long period at 5%. Mrs. B. A. Baxter, Powell, Wyo.	5-room house with bath, kitchenette and milk room; hot and cold water in house; power line within 1 mile of farm; fenced and cross-fenced for sheep; good hen house, brooder houses, and sheep sheds.
55.50 Irrigable acres. Farm unit I of lot 56, T. 55 N., R. 99 W., 6th P. M., Wyoming; 2 miles southeast of Powell, Wyo.; 52.50 acres class 3; 3 acres class 5.	$2,500; cash $1,000, balance on terms at 6%. E. L. Brown, Powell, Wyo.	2-room frame house, small cellar, chicken house and shed; water at house; electricity available at farm.
79.25 irrigable acres. Farm units J and K, lot 41, T. 56 N., R. 98 W., 6th P M., Wyoming; 4 miles northeast of Powell, Wyo.; all class 1 land.	$8,000; cash, or part cash and balance on terms. George Burke, Powell, Wyo.	5-room house, barn, chicken house, garage, granary and fences; electricity available on farm.
66.75 irrigable acres. Farm unit B, lot 41, T. 56 N., R. 98 W., 6th P. M., Wyoming; 5 miles northeast of Powell, Wyo.; 64.75 acres class 3; 2 acres class 5.	$4,000; $1,500 mortgage held by Federal Land Bank which runs for about 10 years; balance cash. Zach Carter, Powell, Wyo.	6-room house, granary, garage, chicken houses, log barn, and fences; electricity available at farm.
73.59 irrigable acres. Farm unit C, lot 40, T. 55 N., R. 99 W., 6th P. M., Wyoming; 4½ miles northwest of Powell, Wyo.; 53.59 acres class 3; 20 acres class 5.	$3,300; cash, $1,500 balance in 5 years at 5%. W. A. & Bertha Cunningham, Powell, Wyo.	6-room house, wired for electricity; hen house for 200 hens; good brooder house, 2-car garage, small barn and granary, large cow shed; most of farm is fenced with woven wire; good stock water well.
33 Irrigable acres. Farm unit E, lot 62, T. 55 N., R. 100 W., 6th P. M., Wyoming; 1 mile southwest of Ralston, Wyo.; all class 2 land.	$3,300; reasonable terms. J. H. Dunton, Ralston, Wyo.	Electricity available at the farm.
43.68 irrigable acres. Farm unit G, lot 63, T. 55 N., R. 100 W., 6th P. M., Wyoming; 1½ miles southwest of Ralston, Wyo.; all class 3 land.	$4,300; reasonable terms. J. H. Dunton, Ralston, Wyo.	Necessary buildings, etc.; electricity available at farm.
65.47 irrigable acres. Farm unit P, lots 62 and 63, T. 55 N., R. 100 W., 6th P. M., Wyoming; 1 mile southwest of Ralston, Wyo.; all class 3 land.	$5,000; reasonable terms. J. H. Dunton, Ralston, Wyo.	Well improved; electricity available at farm.

Shoshone Project, Wyoming—Continued

Description	Price and owner	Remarks
75.50 irrigable acres. Farm unit F, lot 44, T. 56 N., R. 99 W., 6th P. M., Wyoming; 4 miles northeast of Powell, Wyo.; 60.50 acres class 2; 15 acres class 5.	$10,000; part cash, balance on terms. Mrs. Guy Dwinell, Powell, Wyo.	5-room house, garage, barn, granary and chicken house; electricity on farm.
75.98 irrigable acres. Farm unit C, lot 38, T. 56. N, R. 99 W., 6th P. M., Wyoming; 3 miles north of Powell, Wyo.; 66.98 acres class 2; 9 acres class 5.	$6,500; very liberal terms and low rate of interest. Mrs. Anna P. Glasgow, Powell, Wyo.	Small house and well-built straw shed; woven wire fence; school bus and mail routes pass the farm; electricity is available; farm within ¼ mile of oil road to Powell; seeded to sweet clover.
77 Irrigable acres. Farm unit B, lot 77, T. 55 N., R. 99 W., 6th P. M., Wyoming; 3½ miles west of Powell, Wyo.; 47 acres class 2; 30 acres class 5.	$8,700; liberal terms and low rate of interest. Mrs. Anna P. Glasgow, Powell, Wyo.	5-room house, good storage cellar, water in kitchen, good cistern and well, cow barn and sheep shed, good poultry house and large granary; orchard and lawn on school bus and mail route; electricity available at farm.
70.96 irrigable acres. Farm unit H, lot 40, T. 56 N., R. 99 W., 6th P. M., Wyoming; 3½ miles northwest of Powell, Wyo.; 62.96 acres class 2; 8 acres class 5.	$8,000; cash $6,500; balance on long term loan. T. M. Johnston, Route 3, Powell, Wyo.	6-room house, good corrals and out buildings, good well, woven wire sheep fence and cross fence; electricity available at farm.
74 Irrigable acres. Farm unit G, lot 83, T. 55 N., R. 99 W., 6th P. M., Wyoming; 1¾ miles northwest of Powell, Wyo.; 44 acres class 2; 30 acres class 5.	$3,000; ½ cash, balance on easy terms. Joe McPherson, Powell, Wyo.	Fair house, few outbuildings.
80.12 irrigable acres. Farm units A and B, lot 76, T. 55 N., R. 99 W., 6th P. M., Wyoming; 1½ miles northwest of Powell, Wyo.; all class 1 land.	$6,000 for farm unit A; $4,500 for farm unit B. Terms, cash; John Neilsen, Powell, Wyo.	House, 2 garages, barn granary and chicken house on farm unit A, fenced; buildings wired for electricity; no improvements on farm unit B except fences.
79.55 irrigable acres. Farm unit J, lot 57, T. 55 N., R. 99 W., 6th P. M., Wyoming; 1¾ miles south of Powell, Wyo.; 78.55 acres class 3; 1 acre class 5.	$6,500; cash. W. W. Phillips, Powell, Wyo.	Good 5-room house, modern except heat; fenced; electricity available at farm.

Shoshone Project, Wyoming—Continued

Description	Price and owner	Remarks
73.50 irrigable acres. Farm unit A, lot 39, T. 56 N., R. 99 W., 6th P. M., Wyoming; 2 miles north of Powell, Wyo.; 67.50 acres class 2; 6 acres class 5.	$6,000; half cash, balance on terms; Federal loan which can probably be transferred to new owner. F. W. Remington, Powell, Wyo.	Good house, granary and barn; farm well fenced; electricity available at farm.
69 irrigable acres. Farm unit E, lot 38, T. 56 N., R. 99 W., 6th P. M., Wyoming; 1¾ miles north of Powell, Wyo.; all class 2 land.	$3,500; half cash, balance on terms. F. W. Remington, Powell, Wyo.	Small house, good granary, well fenced; electricity available at farm.
77.40 irrigable acres. Farm unit D, lot 38, T. 56 N., R. 99 W., 6th P. M., Wyoming; 2 miles north of Powell, Wyo.; 68.40 acres class 2; 9 acres class 5.	$4,000; half cash, balance on terms. F. W. Remington, Powell, Wyo.	Good house, good granary, and good barn; farm is well fenced.
39.78 irrigable acres. Farm unit B, lot 63, T. 55 N., R. 99 W., 6th P. M., Wyoming; ½ mile west of Powell, Wyo.; all class 1 land.	Price open; reasonable down payment, balance on long time terms at 6%. Frank Thornburgh, 1534 Elm Ave., Long Beach, Calif.	Well developed farm.
39.78 irrigable acres. Farm unit L, lot 63, T. 55 N., R. 99 W., 6th P. M., Wyoming; ¼ mile south of Powell, Wyo.; all class 1 land.	$8,000; ¾ cash, balance on terms. Mrs. Nettie L. Watts, Powell, Wyo.	6-room house with bath, electric lights and city water; good garage, granary, barns, and cow shed.
79.92 irrigable acres. Farm unit L, lot 49, T. 55 N., R. 99 W., 6th P. M., Wyoming; 4 miles southeast of Powell, Wyo.; 34.92 acres class 3; 45 acres class 5.	$6,000; ⅓ cash, balance on terms. Mrs. Nettie L. Watts, Powell, Wyo.	3-room house, barn, granary, potato cellar, large shed, chicken house, and good well.

North Platte Project, Nebraska-Wyoming

160 acres, secs. 13 and 14-23-63. Class A land, 69 acres irrigable; 240 acres adjoining of good farm land or pasture; ¼ mile off oiled road, 15 miles from Torrington. Joins town of Veteran on south and east.	$12,000 cash. Goshen Irrigation District, Torrington, Wyo.	All fenced and cross fenced; 2 sets improvements; 2 good wells and windmills; lake and 2 groves trees.
116 acres irrigable. Secs. 36-26-64.	$2,200 cash. Goshen Irrigation District, Torrington, Wyo.	Lease on State land.
160 acres, secs. 6 and 7-22-61, 122 acres irrigable; 111 acres. Class 4, and balance class 5; 3½ miles east and 1 mile south of town of Yoder, Wyo.	$3,000; $2,200 cash; $800 terms. Goshen Irrigation District, Torrington, Wyo.	Fenced; small sod house, large barn, spud cellar, spring for well near house; Horse Creek runs through corner of place, about ¼ mile, never dry; about 50 acres crop, balance pasture.

Salt River Project, Arizona

160 acres, 5 miles from Phoenix on paved road.	$14,000; Federal Land Bank of Berkeley, 15th and Clay Sts., Oakland, Calif.	Brick dwelling 18 x 30; dairy barn 44 x 108; hay barn 32 x 104; shed.
37.25 acres, 4 miles from Phoenix.	$8,500; Federal Land Bank of Berkeley, 15th and Clay Sts., Oakland, Calif.	Dwelling 30 x 40; milkhouse 16 x 21; barn 45 x 112; 2 sheds and garage.
130 acres, part in alfalfa.	$16,000; Federal Land Bank of Berkeley, 15th and Clay Sts., Oakland, Calif.	Dwelling, with 2 porches, 20 x 36; adobe bunkhouse; corrugated-iron shed, 36 x 60; other buildings; telephone; electricity; running water; shade trees.
40 acres, 4 miles from Chandler on paved road.	$5,000; Federal Land Bank of Berkeley, 15th and Clay Sts., Oakland, Calif.	5-room dwelling; bunkhouse; poultry house; shade trees; family vineyard.

Newlands Project, Nevada

150 acres, 6 miles from Fallon; 72 acres in alfalfa.	$8,000; Federal Land Bank of Berkeley, 15th and Clay Sts., Oakland, Calif.	5-room dwelling; dairy house; cow barn; granary; garage; shop; storage shed; poultry house 20 x 100; shade trees; telephone; electricity.

NOTE.—This is a continued feature from the March issue, and, as therein stated, *the facts presented are subject to verification, as the Bureau of Reclamation cannot undertake this task, and cannot be responsible for the accuracy of representations made.* Interested persons should communicate direct in accordance with the information contained in the listings. Listings should be cleared through project offices shown on the inside of the back cover page.

Orland Project, California

Description	Price and owner	Remarks
40 acres, 2 miles from Orland.	$3,000; Federal Land Bank of Berkeley, 15th and Clay Sts., Oakland, Calif.	Leveled.
40 acres, 4 miles from Orland.	$3,000; Federal Land Bank of Berkeley, 15th and Clay Sts., Oakland, Calif.	Half leveled and planted to alfalfa.

Buffalo Rapids Project, Montana

158 acres; 86 acres irrigated.	$1,000; ½ down. F. G. Bresko, Pasco, Wash.	
131 acres; 99 acres irrigated.	$700 cash. John L. Breum, Fallon, Mont.	
160 acres; 109 acres irrigated.	$2,515, ½ down. Mrs. Maria Brost, Glendive, Mont.	
160 acres; 55 acres irrigated.	$1,030 cash. Anton Edmunds, LaCrosse, Wis.	
160 acres; 113 acres irrigated.	$1,600 cash. Peter Evans, Glendive, Mont.	
792 acres; 424 acres irrigated.	$14,000 cash. Lars E. Kalberg, Glendive, Mont.	
317 acres; 286 acres irrigated.	$5,546, terms. L. R. Kinsey, Glendive, Mont.	
3,153 acres; 1,995 acres irrigated.	Northern Pacific Ry. Co., J. J. Trzcinski, chief land examiner, Miles City, Mont.	
801 acres; 426 acres irrigated.	$7,743, terms. J. N. Rock, Glendive, Mont.	
640 acres; 408 acres irrigated.	$12,000, ½ down. August Schaal, Glendive, Mont.	
301 acres; 139 acres irrigated.	$2,100, ½ down. Estella Searer, Glendive, Mont.	

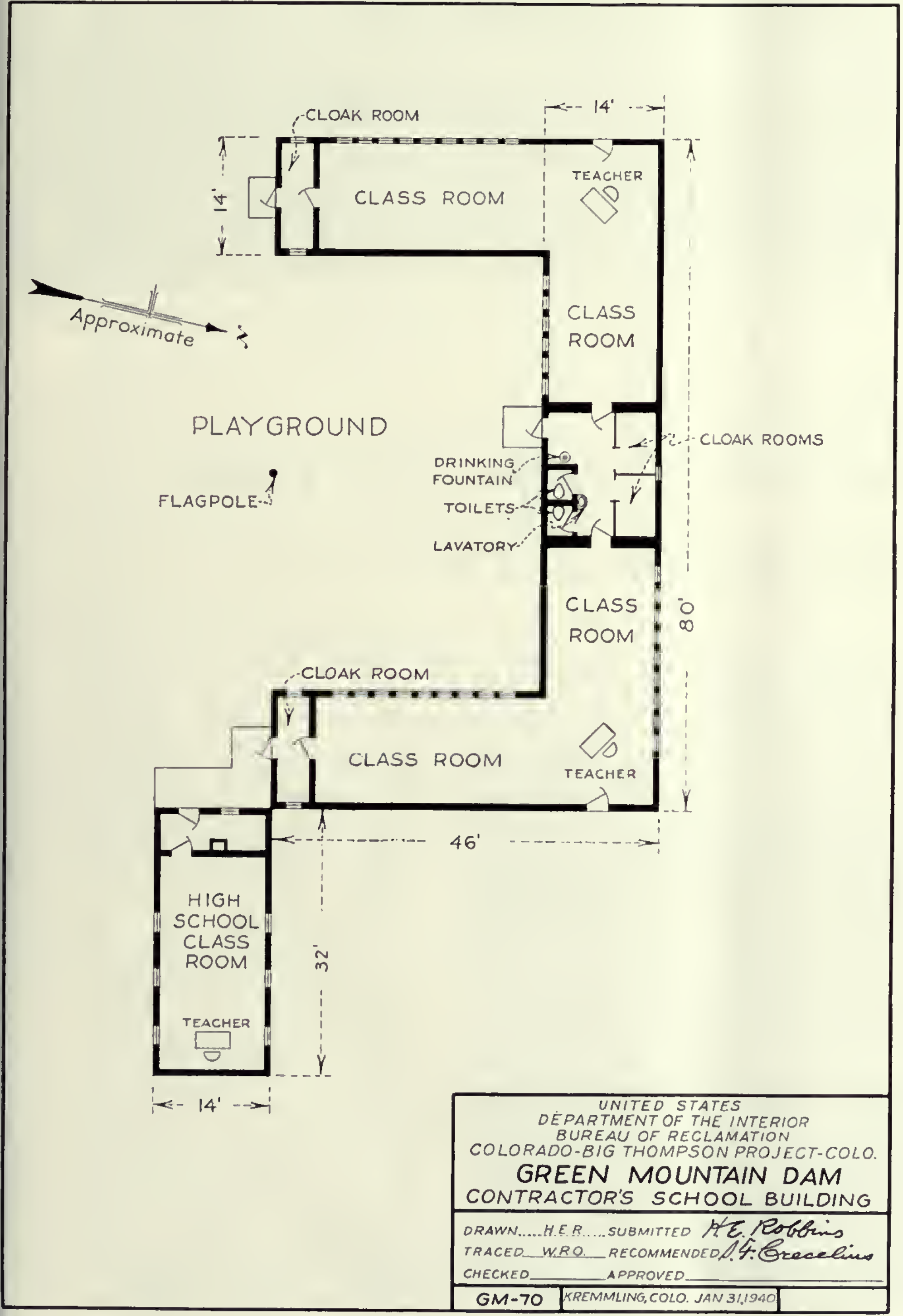
Tucumcari Project, New Mexico

2,016.8 acres.	$26,987.30, cash. Contact Engineer, Tucumcari Project, Tucumcari, N. Mex.	Land to be sold in tracts of 160 acres to 1 person or 320 acres to husband and wife.
680 acres, west S. P. R. R. 1½ miles north Tucumcari, N. Mex., approximately ½ arable.	$6,800, ½ down; balance yearly payments. Edward S. Breen, Tucumcari, N. Mex.	
155 acres, northwest of Tucumcari, N. Mex., adjoining city limits.	$3,416.60; ½ cash, balance monthly or yearly. T. S. Chappell, 619 S. 2d St., Tucumcari, N. Mex.	Price includes $262.50 for improvements; according to Government appraisal a large portion of tract is arable.
280 acres, 11 miles southeast Tucumcari, N. Mex.; approximately ¼ arable.	$1,742.30 cash. Lewis Loy, Tucumcari, N. Mex.	
160 acres, SE. ¼, sec. 8, T. 11, R. 30; approximately 68.5 acres irrigable. 2½ miles northwest of Tucumcari, N. Mex.	Year 1940, $2,500; $1,000 cash, $500 per year at 5%. Year 1941, $3,000; $1,000 cash, $500 per year at 5%. Contact Engineer, Tucumcari Project, Tucumcari, N. Mex.	Desirable for poultry, dairying and stock raising; price subject to change Jan. 1, 1942.
160 acres, 10 miles southeast Tucumcari, N. Mex.	$1,541.80; ½ down, balance terms. Julie A. Dykes, Tucumcari, N. Mex.	Very large portion arable.
N½NW¼ sec. 26, T. 11 N., R. 31 E.	$10 per acre; 33⅓% down; balance in 2 annual payments. W. R. Crump, Tucumcari, N. Mex.	
1,125.6 acres in 40-acre tracts except 1 lot of 5.6 acres.	$7,000 for entire area within project, cash. Guy Elliott, Tucumcari, N. Mex.	

School Facilities and Instruction at Green Mountain Dam

THE United States Government, watchful over the welfare of employees through the educational advancement of their children, provided in the specifications for the construction of the Green Mountain dam and power plant (Colorado-Big Thompson project) that:

"The contractor shall make all necessary arrangements with the proper State and county authorities for school facilities and instruction up to and including the twelfth grade for families of the contractor's employees living in or near his construction camps and for the families of Government employees, which shall be furnished without charge therefor by the contractor . . ."



To comply with the provisions of the specifications for the period from December 1938 to June 1939, the contractor made arrangements with the school district and built a temporary one-room schoolhouse with a capacity of 20 pupils adjacent to the existing district schoolhouse and employed a teacher. For the remainder of the school year the two teachers arranged between themselves to teach all pupils. There were no pupils in the higher grades at this time.

At the beginning of the school term in September 1939, the contractor had failed to reach an agreement with the school district to govern during the entire construction period, and the original agreement continued in force. At this time there were several pupils in the higher grades, and the contractor employed an additional teacher and housed these grades in a temporary building in his camp.

The contractor was urged to complete arrangements for providing the specified school facilities and instruction, and a meeting of representatives of the county, the school district, the contractor, and the Bureau of Reclamation was called for September 22, 1939. Several plans for cooperation between the district and the contractor were discussed, but no agreement could be reached. The contractor then proposed to construct the necessary school buildings in his camp and employ teachers to care for a maximum of 90 pupils. The contractor also agreed to employ three teachers—one for the first to fourth grades, one for the fifth to eighth grades, and one for the high school. This arrangement was approved by all parties concerned. The construction of the buildings was commenced on September 24, 1939, and they were completed on October 21, 1939. The new school was put in service on October 23, 1939.

The grade-school building was constructed of four and one-half 14- by 32-foot buildings formerly used for bunkhouses. The buildings were assembled in the form of a U, as shown by the accompanying photograph. The temporary building erected adjacent to the district school was moved to the new site, and is being used to house the high school. Drawing GM–70, is a floor plan of the building. The bunkhouses used in the construction of the schoolhouse are of "weatherwood" construction and they were remodeled to provide windows occupying about 20 percent of the wall space. Running water and sanitary toilets are provided, and the building is heated with two circulating coal heaters.

Books are purchased by parents of pupils or rented from the contractor.

The attendance at the high school has varied from 5 to 8, and that of the grade school from 39 to 46.

The school has developed an excellent community spirit, and pupils are proud of their school. A nonsectarian Sunday school is being conducted in the school building, which has had an attendance as high as seventy, attracting children from the surrounding community. The success of the latter activity is largely due to the effort of W. N. Hill, chief engineer for the Warner Construction Co., assisted by some of the ladies from the Government camp.

Transmountaineer Makes Its Bow

THE Transmountaineer is issued monthly in the interest of safety by the headquarters office of the Colorado-Big Thompson project. Construction Engineer Porter J. Preston inaugurated this service in January 1940, with issue No. 1.

Looking eastward at contractor's recently constructed school buildings. High school is on right

The Contractor's Camps at Green Mountain Dam[1]

Colorado-Big Thompson Project, Colorado

THE construction of Green Mountain Dam and power plant, a major feature of the Colorado-Big Thompson project, for the most part is seasonal work because of the severity of winter weather conditions. Because the site is remote from centers of population from which a supply of labor adequate for the needs of the contractor might be drawn, it was found necessary to construct and maintain camps for the accommodation of a large number of employees.

Three camps, known as the tunnel camp, the headquarters camp, and the trailer camp, were constructed to meet the various requirements of the contractor's employees.

The Tunnel Camp

General.—The tunnel camp, so named because it was constructed when tunnel excavation was started and originally housed tunnel workers, was built on the left bank of Blue River about 1,200 feet upstream from the upstream portal of the tunnel and about 90 feet above the water surface at the portal. This camp consists of a large building housing a commissary store, a kitchen, two large mess halls, and a recreation hall; 25 bunkhouses; a bath house; and a toilet. The time office and the doctor's office were housed in two of the bunkhouses. A field office for the engineers, a compressor house, an oil house, a warehouse and blacksmith shop, a powder make-up house, and an ambulance house were constructed close to the portal of the tunnel. All buildings are of "weatherwood" construction, except that the compressor house and oil house are framed with galvanized-iron sheathing, and the engineers' office, the blacksmith shop, the powder make-up house, and the ambulance house were frame buildings covered with wood sheathing and tar roofing paper.

The commissary.—The commissary is of ample size and carries a complete line of work clothes, shoes, toilet articles, tobacco, cigarettes, soft drinks, 3.2 percent beer, candies, and other miscellaneous articles usually purchased by men on a construction job. A barber shop is also maintained in the commissary building.

Mess hall.—The mess hall is furnished with well-constructed tables and benches of homemade type, and tables are covered with oilcloth. The mess hall will accommodate approximately 200 men and is heated by two coal-burning stoves. Meals are served as follows: Breakfast, 7 and 8:30 a. m.; regular noon meal, 12 m.; 2:30 p. m., lunches are prepared for men going on swing shift; 5 p. m., regular evening meal; 11 p. m., meal served for men going on graveyard shift; 1 a. m., meal for men coming off swing shift. Sack lunches are furnished for all men on shifts who cannot come to regular meals. The quality of food is good and the quantity is ample. Two men are regularly employed in cleaning the mess hall, kitchen, and bunkhouses.

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[1] A complete description of the Green Mountain Dam and power plant, feature of the Colorado-Big Thompson project, appeared in the October 1939 issue of the RECLAMATION ERA.

Looking eastward from top of stock pile at contractor's temporary camp

Bunkhouses.—Bunkhouses are of "weatherwood" construction, size 14 x 32 feet, partitioned to make two rooms. Each room is equipped with four single beds which are furnished with mattresses, blankets, sheets, pillows, and pillow cases. The linens on the beds are changed weekly, and rooms are swept each day. Each room is equipped with a coal-burning heater, for which fuel is supplied and fires kindled each morning as necessary. Bunkhouses are mopped out once each week. The average distance of bunkhouses from the bathhouse is 200 feet.

Rates charged for accommodations at commissary.—The charge for board at the commissary with lodging in bunkhouses is $1.35 per day. Anyone not on shift may check out of the boarding house for three meals or more by signing the "check-out register," and he is credited with 40 cents per meal while absent. Men employed on the work and not rooming in bunkhouses can get board at the commissary at the rate of 40 cents per meal.

Bathhouse.—The bathhouse is equipped with 4 showers, 4 toilets, 110 lockers for clothes of employees; 2 coal-burning, circulating heaters; 1 large hot-water heater; and one 250-gallon capacity hot-water tank. Hot and cold showers are available at all times. A regular attendant is employed in the bathhouse, and it is kept in a sanitary condition. One outside toilet to accommodate six persons is located near the bath house and is well screened and kept in a sanitary condition.

Recreation.—The recreation hall adjoining the commissary is equipped with a pool table and two tables for card games. A charge of 5 cents per game is made for playing pool. No charge is made for the use of the card tables. An area near the bunkhouses has been reserved for horseshoe games, for which no charge is made. A baseball diamond has been laid out near the commissary and equipment furnished, for which no charge is made.

Headquarters camp.—The headquarters camp is located about 1,000 feet upstream from the southwest end of the axis of the dam and from 15 to 50 feet higher than the crest of the dam, and consists of an office building 28 x 60 feet, a carpenter shop 28 x 60 feet, a machine shop 152 x 76 feet, and 48 houses of 2 to 5 rooms to accommodate supervisory and other employees with families. The machine shop is constructed of "weatherwood" on a structural-steel and wood frame. All other buildings are of "weatherwood" on wood frames. The 4- and 5-room residences are equipped with toilet, bath, garage, and in some instances, with basements. All are provided with brick chimneys. Two community bath houses are centrally located in the camp and are equipped with toilets, hot and cold showers, and laundry rooms for use of residents in the 2- and 3-room houses. The camp is provided with water, sewer, sewage disposal, and lighting systems, and the camp is maintained in a sanitary condition. For single supervisory employees in this camp, an 8-room dormitory is maintained, which is equipped with toilets and hot and cold showers. Complete bedding is furnished with rooms in the dormitory. The lobby of the dormitory is heated by means of an oil-burning heater.

Monthly rental rates for the above accommodations are as follows:

2-room houses	$22.50
3-room houses	27.50
4-room houses	35.00–50.00
5-room houses	40.00–50.00
1 room in dormitory	12.50

The above rates include water, but do not include electricity except in the dormitory.

(*Continued on page 123*)

Looking southeast from edge of trash-rack excavation at contractor's permanent camp

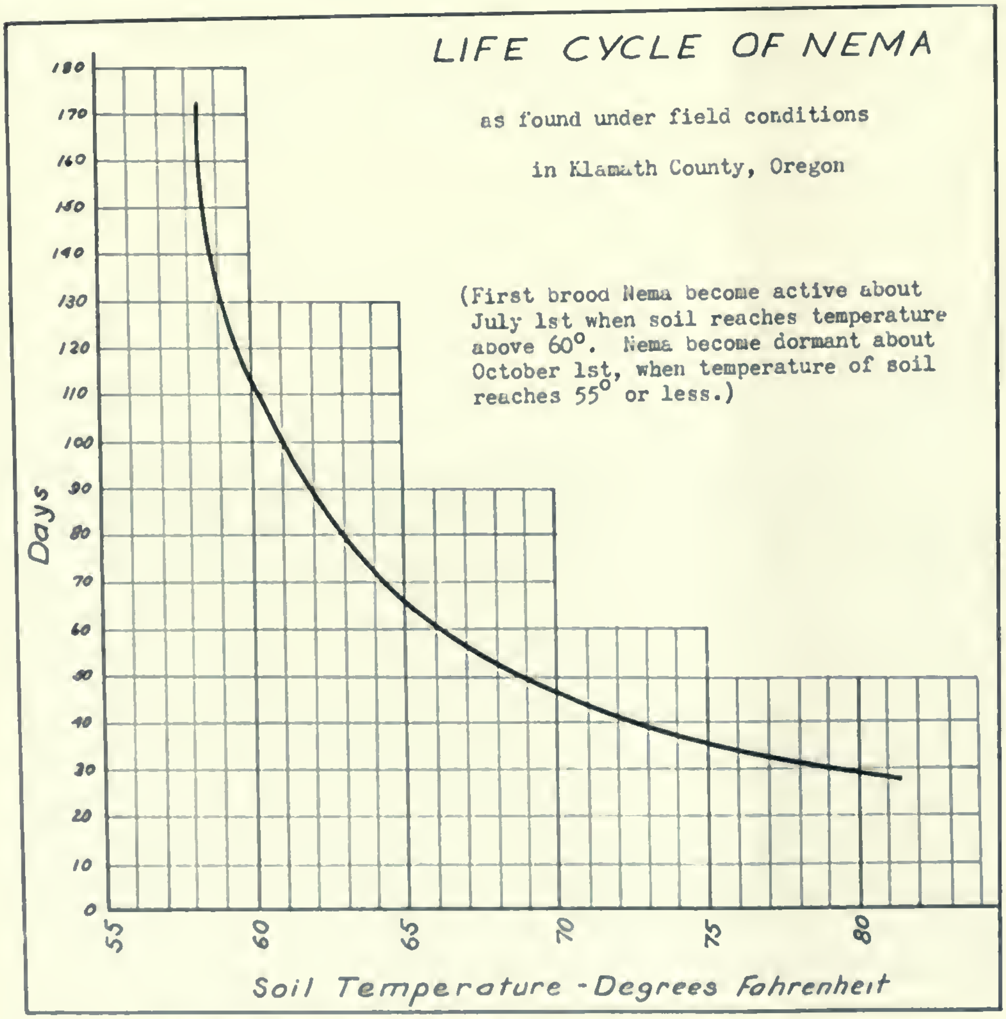
Potato Nematode Field Investigations

By C. A. HENDERSON, *Klamath County Extension Agent*

FIELD investigations conducted in Klamath County, Oreg., indicate that soil temperature and types of humus material applied to the soil are the points of attack in the successful control or limitation of nematodes on potatoes and other crops. Past experimental work has indicated that in temperatures under 55° nematodes are dormant and that the higher the temperature the faster the life cycle is completed. If soil temperatures could be maintained at 62°, indications are that the completion of the life cycle would require 90 days. On the other hand, less than 50 days would be required if soil temperatures were maintained at 70°.

In determining the practical value of this information in nematode control, the Oregon Experiment Station and Klamath County, Oreg., have cooperated in conducting field investigations. On several farms where irrigation was undertaken every 2 or 3 days, it was found that soil temperatures were held between 62° and 63° and that little, if any, nematode infestation appeared. In 1938 and 1939 it was also discovered that the humus content of the soil was an important factor. In heavy packed soils containing little humus it was found impossible to control temperatures to any great degree.

In 1939, Will Blackman of the Pine Grove district, grew a successful crop of potatoes on land which in previous years had been badly infested with nematodes. From 1933 to 1937 this land had been in alfalfa. In 1938 it was planted to sugar beets. The beets were a failure, so on July 9 summer fallowing was started and continued to September 10 when a crop of rye was planted. On May 10, 1939, the rye being 3 to 4 feet high, the land was plowed, and a few days later planted to potatoes. The field was then irrigated on July 8, 13, 18, and 26 and after that every third day until maturity. In the fall of 1939 when the crop was harvested the potatoes were found to be free of nematode and of excellent quality. In fact, Mr. Blackman stated that the potatoes were as good as those raised on this land when it was first cropped to potatoes some 12 to 15 years before. And although in the past there had been some evidence of both scab and rhizoctonia, this year neither of these diseases was present in the field.



On two other farms where the land was irrigated every 2 or 3 days, similar to the practice followed on Mr. Blackman's farm, no nematode were found during 1939. Upon another farm having soil particularly lacking in humus, even though irrigation had been carried on every 2 or 3 days throughout the season, considerable nematode was present.

Trials were also carried on by Mr. A. E. Gross, superintendent of the experiment station tracts on the Klamath project. Although conditions were such that considerable variation occurred, some fairly conclusive results were obtained. The following is taken from the reports of Mr. Gross:

"Field observations during the past 2 or 3 years have led to the belief that frequent irrigation of potato fields has lowered the temperature of those fields resulting in less loss from nematodes. In an attempt to obtain some definite information on the observations, an irrigation experiment was conducted with the cooperation of Will Blackman who furnished the land and cultivated and harvested the potatoes. This experiment as originally planned called for irrigation at intervals of every 2, 4, 6, 8, and 10 days. It early became apparent, however, that more frequent irrigations were going to be necessary to keep the soil temperature down and to keep the potatoes sufficiently wet. The time intervals were then increased to every 1, 2, 3, 4, and 5 days. Each irrigation interval was in triplicate. Irrigations began on July 7 and ended August 23. Temperatures were taken each morning at about 10 a. m. at 6-inch depth in the potato rows.

"The following table gives average daily temperature in °F. for each irrigation interval:

TABLE I.—*Average daily temperature in °F.*

Replication	Irrigation interval (days)				
	1	2	3	4	5
1	64.5	65.5	66.0	66.5	68.0
2	65.0	65.5	66.0	66.5	67.5
3	65.0	65.0	66.0	66.5	67.0
Average	64.8	65.3	66.0	66.5	67.5

"The average daily temperature of the irrigation water that was applied to these plots was 73.0° F. Thus the average loss of heat due to evaporation on daily irrigated plots was 8.2° F. and for every fifth day irrigation it was 5.5° F.

"The above temperatures are generally higher than was desired or expected. The experimental area was approximately one-half mile removed from the irrigation canal and by the time the small quantity of water used had gotten to the area it had become warmed considerably.

"On the basis of the soil temperatures obtained, it was expected that the percentage of potatoes showing external nematode symptoms would increase directly as the temperature increased. In the accompanying table it will be seen that the percentage of infested potatotes decreased through every third day irrigation and then jumped rapidly for fourth and fifth day irrigation.

"A satisfactory explanation for the gradual decrease and sudden jump in infected tubers is not at hand. It may be due to the depth at which temperatures were taken. A depth of 3 or 4 inches may give a more accurate picture of actual temperature conditions in the region where the majority of the potatoes are found. At a shallower depth too frequent irrigation might tend to keep the temperature close to that of the water which, in this experiment, was high.

"Considered as a whole, however, the data show some relation between temperature and the extent of nematode symptoms.

"The idea of using irrigations to control external nemic symptoms on potatoes was put to test by four commercial growers in Klamath County during the 1939 season, in cooperation with Eric Wold, county pest inspector. The tests were on known infested fields. At digging time this fall, infested tubers were found in only one of the four tests. In the field showing eelworm, it was noted that irrigation early in the season was inadequate to hold the temperature down to the 62° to 64° F. that was desired."

TABLE II.—*Percent of potatoes showing external nemic symptoms*

Replication	Irrigation interval (days)				
	1	2	3	4	5
	50.8	46.1	39.9	36.6	54.3
2	41.5	33.4	29.8	62.4	62.0
3	53.4	59.9	30.5	55.8	40.9
Average	48.6	46.6	33.4	51.6	52.4

Tentative conclusions.—On soils of the Klamath project, soil temperatures can be maintained at 62° to 63° F. during the growing season, by keeping soils well supplied with succulent humus material and by light frequent irrigations. Nematode damage is eliminated or reduced to a minimum at soil temperatures under 63° F. Such crops as potatoes thrive best at this low temperature.

Improvement to Belle Fourche Dam

(*Continued from page 116*)

trol was obtained by locating borrow pits within the reservoir area and selecting material to give not only proper gradation but also a practicable moisture content for compaction. All hauling was by dump trucks, and loading was done by dipper shovels with two in the earth borrow pits and two at the rock quarry. At the gravel pit one shovel took care of stripping and excavation while loading was done by bulldozers and conveyor belt. At first, rock was hauled from Spearfish, 28 miles, but the quarry proved inadequate and thereafter Whitewood became the source of supply, requiring a 40-mile haul. Operations were continuous, being carried on three shifts per day, and materials went into place at the average rate of 1,640 cubic yards per 24 hours.

A section of embankment planned near the north end of the dam was eliminated and final quantities were somewhat below the estimate. Following are the contract earnings:

Item 1: Earth fill—41,021 cubic yards at $0.26	$10, 665 .46
Item 2: Gravel fill below 2,925—24,691 cubic yards at $0.55	13, 580. 05
Item 3: Gravel fill above 2,925—27,402 cubic yards at $0.60	16, 441. 20
Item 4: Rock riprap—18,375 cubic yards at $2.90	53, 287. 50
Item 5: Drilling—3,002 linear feet at $0.50	1, 501. 00
Total	95, 475. 21

Fall weather was exceptionally favorable for carrying on hauling operations and only one day was lost on account of precipitation. Temperatures during October were at nearly summer level, and it was possible to continue fall irrigation so that run-off was stored in the soil and practically none was lost on account of the dam improvement. Storing in the reservoir was resumed on November 1, when all filling including rock had been completed to elevation 2,925. On December 17, when the entire job was completed, the water level stood at 2,930.2.

Contractor's Camps

(*Continued from page 121*)

Rates for electricity are as follows:

First 50 kilowatt-hours per month, 4 cents each.

All over 50 kilowatt-hours per month, 2 cents each.

None of the houses is furnished, but lumber and other materials are furnished free by the contractor for tables, chairs, and other camp furniture.

The trailer camp.—During the early stages of the work, trailers, and small shacks, and tents were distributed over the reservation in such manner as to make it impossible to enforce sanitary regulations, and the contractor was requested to lay out streets and provide water and sanitary toilets in an area selected for the purpose on the left bank of Blue River about 1 mile upstream from the axis of the dam. The contractor laid out and gravel-surfaced streets, and installed water, sewer, and street-lighting systems. There are two community bathhouses in this camp centrally located, equipped with toilets, hot and cold showers, and coal-burning heaters. The laundry rooms in connection with bathhouses are equipped with laundry trays for which hot and cold water is furnished. Pits for the disposal of garbage are provided near the camp and garbage is collected every other day, placed in pits, and covered with earth. All rubbish is burned. A charge of $6 per month is made for a space 30 x 40 feet in this camp, which price includes free use of electricity for lighting, water, bathhouse, a laundry room, and collection and disposal of garbage and trash.

Medical service.—A resident physician is employed by the contractor, and occupies a well-equipped office in the headquarters camp. Three beds are provided in the same building with the doctor's office for emergency cases.

San Luis Project Feasible

DURING April, Secretary of the Interior Harold L. Ickes transmitted a report to Congress on the San Luis project on the Rio Grande in Colorado, stating that the project was feasible and recommending its construction under the reclamation law. The report was accompanied by a letter from the President stating the project should be constructed by the Bureau of Reclamation, if and when it is constructed.

The irrigation and flood-control development would cost an estimated $17,465,000, of which $10,585,000 would be allocated to irrigation to be repaid by water users on 400,000 acres of developed land around Monte Vista now in need of supplemental irrigation water, and $6,880,000 would be allocated to flood control under a finding agreed to by the Corps of Engineers with no reimbursement contemplated.

The report contemplates construction of Wagon Wheel Gap Dam to form a reservoir which would impound 1,000,000 acre-feet of water near Creede, two reservoirs on the Conejos River southwest of Alamosa with a combined capacity of 100,000 acre-feet, and a small transmountain diversion from the Colorado River Basin to the Rio Grande Basin. The Bureau report finds power development unwarranted at this time but provisions for future development are included.

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Projects under construction or operated in whole or in part by the Bureau of Reclamation

Project	Office	Official in charge		Chief clerk	District counsel	
		Name	Title		Name	Address
All-American Canal	Yuma, Ariz	Leo J. Foster	Construction engineer	J. C. Thrailkill	R. J. Coffey	Los Angeles, Calif.
Belle Fourche	Newell, S. Dak	F. C. Younghlutt	Superintendent	J. P. Siebeneicher	W. J. Burke	Billings, Mont.
Boise	Boise, Idaho	R. J. Newell	Construction engineer	Robert B. Smith	B. E. Stoutemyer	Portland, Oreg.
Boulder Canyon [1]	Boulder City, Nev	Irving C. Harris	Director of power	Gail H. Baird	R. J. Coffey	Los Angeles, Calif.
Buffalo Rapids	Glendive, Mont	Paul A. Jones	Construction engineer	Edwin M. Bean	W. J. Burke	Billings, Mont.
Buford-Trenton	Williston, N. Dak	Parley R. Neeley	Resident engineer	Robert L. Newman	W. J. Burke	Billings, Mont.
Carlsbad	Carlsbad, N. Mex	L. E. Foster	Superintendent	E. W. Shepard	H. J. S. Devries	El Paso, Tex.
Central Valley	Sacramento, Calif	W. R. Young	Supervising engineer	E. R. Mills	R. J. Coffey	Los Angeles, Calif.
Shasta Dam	Redding, Calif	Ralph Lowry	Construction engineer		R. J. Coffey	Los Angeles, Calif.
Friant division	Friant, Calif	R. B. Williams	Construction engineer		R. J. Coffey	Los Angeles, Calif.
Delta Division	Antioch, Calif	Oscar G. Boden	Construction engineer		R. J. Coffey	Los Angeles, Calif.
Colorado-Big Thompson	Estes Park, Colo	Porter J. Preston	Supervising engineer	C. M. Voyen	J. R. Alexander	Salt Lake City, Utah
Colorado River	Austin, Tex	Ernest A. Moritz	Construction engineer	William F. Sha	H. J. S. Devries	El Paso, Tex.
Columbia Basin	Coulee Dam, Wash	F. A. Banks	Supervising engineer	C. B. Funk	B. E. Stoutemyer	Portland, Oreg.
Deschutes	Bend, Oreg	D. S Stuver	Construction engineer	Noble O. Anderson	B. E. Stoutemyer	Portland, Oreg.
Gila	Yuma, Ariz	Leo J. Foster	Construction engineer	J. C. Thrailkill	R. J. Coffey	Los Angeles, Calif.
Grand Valley	Grand Junction, Colo	W. J. Chiesman	Superintendent	Emil T. Ficenec	J. R. Alexander	Salt Lake City, Utah.
Kendrick	Casper, Wyo	Irvin J. Matthews	Construction engineer [2]	George W. Lyle	W. J. Burke	Billings, Mont.
Klamath	Klamath Falls, Oreg	B. E. Hayden	Superintendent	W. I. Tingley	B. E. Stoutemyer	Portland, Oreg.
Milk River	Malta, Mont	H. H. Johnson	Superintendent	E. E. Chabot	W. J. Burke	Billings, Mont.
Minidoka	Burley, Idaho	Stanley R. Marean	Superintendent	G. C. Patterson	B. E. Stoutemyer	Portland, Oreg.
Minidoka Power Plant	Burley, Idaho	Samuel A. McWilliams	Resident engineer		B. E. Stoutemyer	Portland, Oreg.
Moon Lake	Provo, Utah	E. O. Larson	Construction engineer	Francis J. Farrell	J. R. Alexander	Salt Lake City, Utah.
North Platte	Guernsey, Wyo	C. F. Gleason	Superintendent of power	A. T. Stimpfig	W. J. Burke	Billings, Mont.
Ogden River	Provo, Utah	E. O. Larson	Construction engineer	Francis J. Farrell	J. R. Alexander	Salt Lake City, Utah.
Orland	Orland, Calif	D. L. Carmody	Superintendent	W. D. Funk	R. J. Coffey	Los Angeles, Calif.
Owyhee	Boise, Idaho	R. J. Newell	Construction engineer	Robert B. Smith	B. E. Stoutemyer	Portland, Oreg.
Parker Dam Power	Parker Dam, Calif	E. C. Koppen	Construction engineer	George B. Snow	R. J. Coffey	Los Angeles, Calif.
Pine River	Vallecito, Colo	Charles A. Burns	Construction engineer	Frank E. Gawn	J. R. Alexander	Salt Lake City, Utah.
Provo River	Provo, Utah	E. O. Larson	Construction engineer	Francis J. Farrell	J. R. Alexander	Salt LakeCity, Utah.
Rapid Valley	Rapid City, S. Dak	Horace V. Hubbell	Construction engineer		W. J. Burke	Billings, Mont.
Rio Grande	El Paso, Tex	L. R. Fiock	Superintendent	H. H. Berryhill	H. J. S. Devries	El Paso, Tex.
Riverton	Riverton, Wyo	H. D. Comstock	Superintendent	C. B. Wentzel	W. J. Burks	Billings, Mont.
Sanpete	Provo, Utah	E. O. Larson	Construction engineer	Francis J. Farrell	J. R. Alexander	Salt Lake City, Utah.
Shoshone	Powell, Wyo	L. J. Windle	Superintendent	L. J. Windle [2]	W. J. Burke	Billings, Mont.
Heart Mountain division	Cody, Wyo	Walter F. Kemp	Construction engineer	L. J. Windle [2]	W. J. Burke	Billings, Mont.
Sun River	Fairfield, Mont	A. W. Walker	Superintendent		W. J. Burke	Billings, Mont.
Truckee River Storage	Reno, Nev	Floyd M. Spencer	Construction engineer		J. R. Alexander	Salt Lake City, Utah.
Tucumcari	Tucumcari, N. Mex	Harold W. Mutch	Engineer	Charles L. Harris	H. J. S. Devries	El Paso, Tex.
Umatilla (McKay Dam)	Pendleton, Oreg	C. L. Tice	Reservoir superintendent		B. E. Stoutemyer	Portland, Oreg.
Uncompahgre: Repairs to canals	Montrose, Colo	Denton J. Paul	Engineer	Ewalt P. Anderson	J. R. Alexander	Salt Lake City, Utah.
Upper Snake River Storage [3]	Ashton, Idaho	I. Donald Jerman	Construction engineer [2]	Emmanuel V. Hillius	B. E. Stoutemyer	Portland, Oreg.
Vale	Vale, Oreg	C. C. Ketchum	Superintendent		B. E. Stoutemyer	Portland, Oreg.
Yakima	Yakima, Wash	J. S. Moore	Superintendent	Conrad J. Ralston	B. E. Stoutemyer	Portland, Oreg.
Roza division	Yakima, Wash	Charles E. Crownover	Construction engineer	Alex S. Harker	B. E. Stoutemyer	Portland, Oreg.
Yuma	Yuma, Ariz	C. B. Elliott	Superintendent	Jacob T. Davenport	R. J. Coffey	Los Angeles, Calif.

[1] Boulder Dam and Power Plant.

[2] Acting.

[3] Island Park and Grassy Lake Dams.

Projects or divisions of projects of Bureau of Reclamation operated by water users

Project	Organization	Office	Operating official		Secretary	
			Name	Title	Name	Address
Baker (Thief Valley division) [1]	Lower Powder River irrigation district	Baker, Oreg	A. J. Ritter	President	F. A. Phillips	Keating.
Bitter Root [4]	Bitter Root irrigation district	Hamilton, Mont	G. R. Walxh	Manager	Elsie H. Wagner	Hamilton.
Boise [1]	Board of Control	Boise, Idaho	Wm. H. Tuller	Project manager	L. P. Jensen	Boise.
Boise [1]	Black Canyon irrigation district	Notus, Idaho	W. H. Jordan	Superintendent	L. M. Watson	Caldwell.
Burnt River	Burnt River irrigation district	Huntington, Oreg	Edward Sullivan	President	Harold H. Hursh	Huntington.
Frenchtown	Frenchtown irrigation district	Frenchtown, Mont	Edward Donlan	President	Ralph P. Schaffer	Huson.
Grand Valley, Orchard Mesa [3]	Orchard Mesa irrigation district	Grand Junction, Colo	C. W. Tharp	Superintendent	G. J. McCormich	Grand Jctn.
Humboldt	Pershing Co. Water Construction Dist	Lovelock, Nev	Roy Mefley	Superintendent	C. H. Jones	Lovelock.
Huntley [4]	Huntley irrigation district	Ballatine, Mont	E. E. Lewis	Manager	H. S. Elliott	Ballatine.
Hyrum [3]	South Cache W. U. A.	Hyrum, Utah	H. S. Richards	Superintendent	Harry G. Parker	Logan.
Klamath, Langell Valley [1]	Langell Valley irrigation district	Bonanza, Oreg	Chas. A. Revell	Manager	Chas. A. Revell	Bonanza.
Klamath, Horsefly [1]	Horsefly irrigation district	Bonanza, Oreg	Henry Schmor, Jr	President	Dorothy Eyers	Bonanza.
Lower Yellowstone [4]	Board of Control	Sidney, Mont	Axel Persson	Manager	Axel Persson	Sidney.
Milk River: Chinook division [4]	Alfalfa Valley irrigation district	Chinook, Mont	A. L. Benton	President	R. H. Clarkson	Chinook.
	Fort Belknap irrigation district	Chinook, Mont	H. B. Bonefright	President	L. V. Bogy	Chinook.
	Zurich irrigation district	Harlem, Mont	C. A. Watkins	President	H. M. Montgomery	Chinook.
	Harlem irrigation district	Harlem, Mont	Thos. M. Everett	President	Geo. H. Tout	Harlem
	Paradise Valley irrigation district	Zurich, Mont	R. E. Musgrove	President	J. F. Sharples	Zurich.
Minidoka: Gravity [1]	Minidoka irrigation district	Rupert, Idaho	Frank A. Ballard	Manager	O. W. Paul	Rupert.
Pumping	Burley irrigation district	Burley, Idaho	Hugh L. Crawford	Manager	Frank O. Redfield	Burley.
Gooding [1]	Amer. Falls Reserv. Dist. No. 2	Gooding, Idaho	S. T. Baer	Manager	Ida M. Johnson	Gooding.
Newlands [3]	Truckee-Carson irrigation district	Fallon, Nev	W. H. Wallace	Manager	H. W. Emery	Fallon.
North Platte: Interstate division [4]	Pathfinder irrigation district	Mitchell, Nebr	T. W. Parry	Manager	Flora K. Schroeder	Mitchell.
Fort Laramie division [4]	Gering-Fort Laramie Irrigation district	Gering, Nebr	W. O. Fleenor	Superintendent	C. G. Klingman	Gering.
Fort Laramie division [4]	Goshen irrigation district	Torrington, Wyo	Floyd M. Roush	Superintendent	Mary E. Harrach	Torrington.
Northport division [4]	Northport irrigation district	Northport, Nebr	Mark Iddings	Manager	Mabel J. Thompson	Bridgeport.
Ogden River	Ogden River W. U. A.	Ogdeu, Utah	David A. Scott	Superintendent	Wm. P. Stephens	Ogden.
Okanogan [1]	Okanogan irrigation district	Okanogan, Wash	Nelson D. Thorp	Manager	Nelson D. Thorp	Okanogan.
Salt Lake Basin (Echo Res.) [3]	Weber River Water Users' Assn	Ogden, Utah	D. D. Harris	Manager	D. D. Harris	Layton.
Salt River [2]	Salt River Valley W. U. A.	Phoenix, Ariz	H. J. Lawson	Superintendent	F. C. Henshaw	Phoenix.
Shoshone: Garland division [4]	Shoshone irrigation district	Powell, Wyo	Paul Nelson	Acting irri. supt	Harry Barrows	Powell.
Frannie division [4]	Deaver irrigation district	Deaver, Wyn	Floyd Lucas	Manager	R. J. Schwendiman	Deaver.
Strawberry Valley	Strawberry Water Users' Assn	Payson, Utah	S. W. Grotegut	President	E. G. Breeze	Payson.
Sun River: Fort Shaw division [4]	Fort Shaw irrigation district	Fort Shaw, Mont	C. L. Bailey	Manager	G. L. Bailey	Fort Shaw.
Greenfields division [4]	Greenfields irrigation district	Fairfield, Mont	A. W. Walker	Manager	H. P. Wangen	Fairfield.
Umatilla: East division [1]	Hermiston irrigation district	Hermiston, Oreg	E. D. Martin	Manager	Enos D. Martin	Hermiston.
West division [1]	West Extension irrigation district	Irrigon, Oreg	A. C. Houghton	Manager	A. C. Houghton	Irrigon.
Uncompahgre [3]	Uncompahgre Valley W. U. A.	Montrose, Colo	Jesse R. Thompson	Manager	H. D. Galloway	Montrose.
Yakima, Kittitas division [1]	Kittitas reclamation district	Ellensburg, Wash	G. G. Hughes	Acting manager	G. L. Sterling	Ellensburg.

[1] B. E. Stoutemyer, district counsel Portland, Oreg.

[2] R. J. Coffey, district counsel, Los Angeles, Calif.

[3] J. R. Alexander, district counsel, Salt Lake City, Utah.

[4] W. J. Burke, district counsel, Billings, Mont.

Important investigations in progress

Project	Office	In charge of—	Title
Colorado River Basin, sec. 15 (Colo., Wyo., Utah, N. Mex.)	Denver, Colo	E. B. Debler	Senior engineer.
Fort Peck Pumping (Mont., N. Dak.)	Denver, Colo	W. G Sloan	Engineer.
Missouri River Pumping (N. Dak, S. Dak.)	Denver, Colo	W. G. Sloan	Engineer.
Yellowstone Basin (Mout.)	Helena, Mont	F. V. Munro	Engineer.
Big Horn Basin (Mont., Wyo.)	Denver, Colo	W. G. Sloan	Engineer.
Arkansas Valley (Colo., Kans.)	Denver, Colo	A. N. Thompson	Engineer.
Challis, Salmon River (Idaho)	Salmon City, Idaho	O. L. Kime	Associate engineer.
Robert Lee (Tex.)	Austin, Tex	E. A. Moritz	Construction engineer.
Colorado-Great Basin	Salt Lake City, Utah	E. G. Nielsen	Engineer.
Williams, Hassayampa, Little Colorado (Ariz.)	Phoenix, Ariz	Major O. Simons	Associate engineer.

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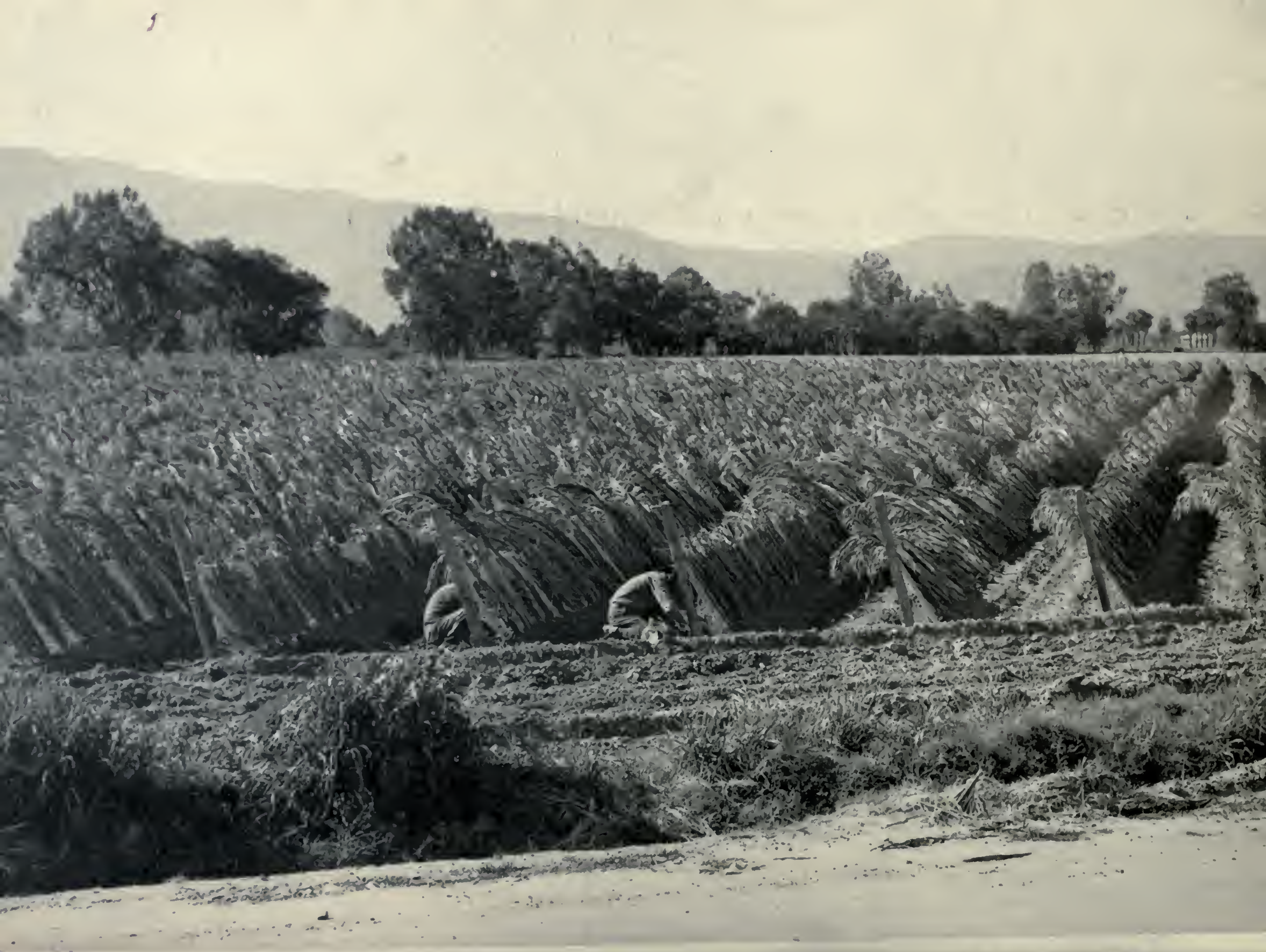
SALLIE A. B. COE, *Editor.*



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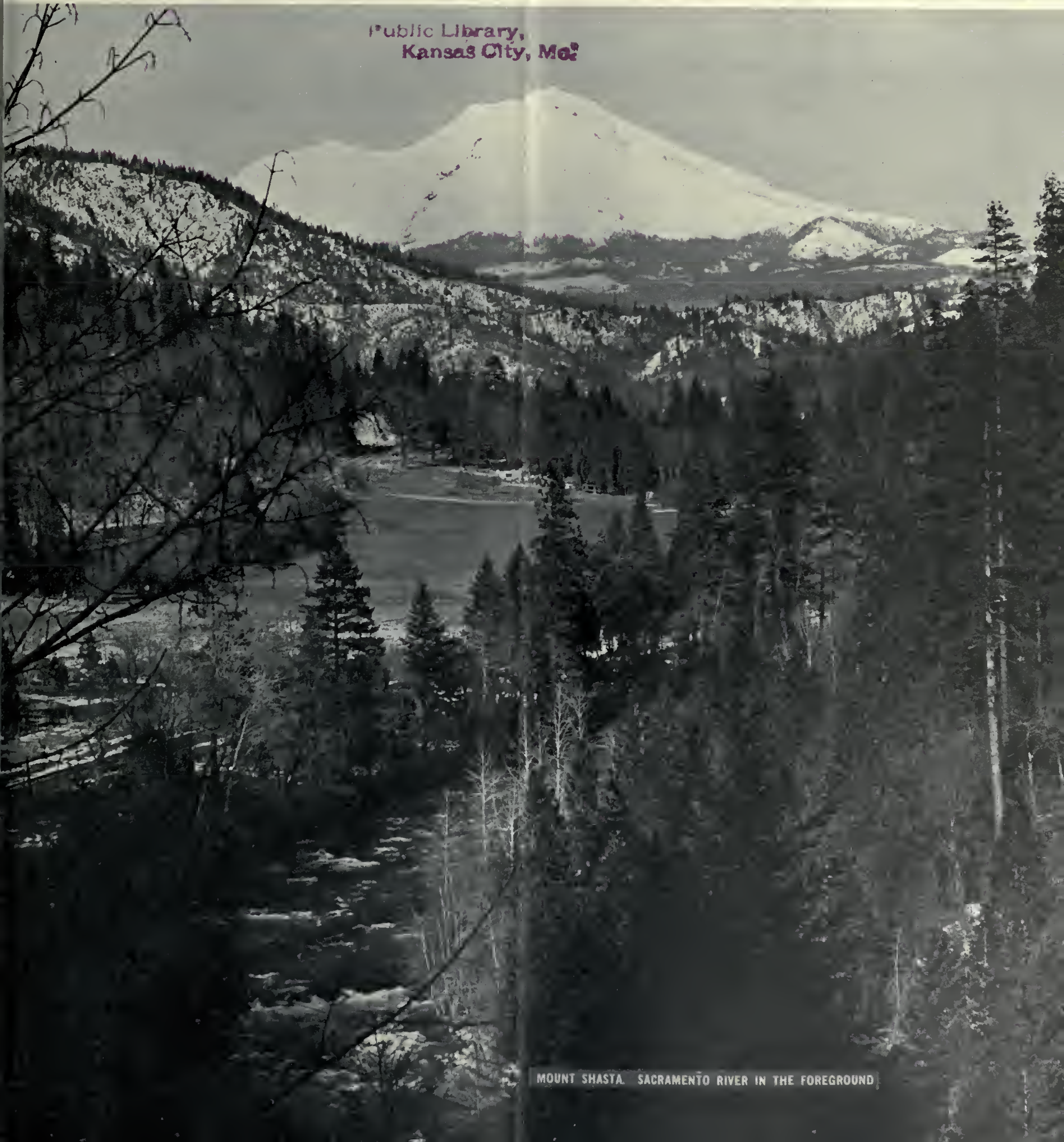

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By the President of the
United States of America

A Proclamation

WHEREAS the exigencies of international conflict may be expected to deter travel by American citizens to the areas involved, and

WHEREAS no such deterrent to travel exists among the friendly nations of the Western Hemisphere, and

WHEREAS it is important that we in the Americas further consolidate our unity by a better knowledge of our own and each others' countries through the instrumentality of travel, and

WHEREAS the facilities of the Government of the United States may well be devoted to the encouragement of so laudable a program,

NOW, THEREFORE, I, FRANKLIN D. ROOSEVELT, President of the United States of America, do proclaim 1940 as Travel America Year and do invite our own citizens, and friends from other lands, to join in a great travel movement, so that our peoples may be drawn even more closely together in sympathy and understanding.

IN WITNESS WHEREOF I have hereunto set my hand and caused the seal of the United States of America to be affixed.

DONE at the City of Washington this thirteenth day of January in [SEAL] the year of our Lord nineteen hundred and forty, and of the Independence of the United States of America the one hundred and sixty-fourth.

FRANKLIN D ROOSEVELT

By the President:
CORDELL HULL
Secretary of State.

PRICE
ONE
DOLLAR
A YEAR

THE RECLAMATION ERA

VOLUME 30 MAY 1940 • NUMBER 5

Construction Features of the Glendive Unit

Buffalo Rapids Project, Montana

By **D. R. BURNETT**, *Office Engineer*

IN A previous issue of the RECLAMATION ERA there appeared an article giving general information concerning the Buffalo Rapids project. To lead up to the subject matter of this article a brief summary of the information given in the first article is necessary.

The project is located in eastern Montana, extending along the Yellowstone River between Miles City and the upper end of the Lower Yellowstone project. Because of prolonged drought conditions during the past 10 years this once productive valley was rapidly becoming untenable as a farming center. Mainly through the efforts of the Mid-Yellowstone Recovery Association, the Bureau of Reclamation was provided with funds to make an investigation of the valley to determine the feasibility of using water from the Yellowstone River for irrigation of the land.

In 1935 this investigation was completed and it was determined that approximately 56,000 acres of land in the valley were susceptible to irrigation by any one of three methods. These methods consisted of a gravity scheme, pumping scheme, and combined gravity and pumping scheme. From an economic standpoint none of these three schemes was feasible, in that the construction cost was estimated to be too high for the land to repay the entire cost. Because of the urgent need for relief expenditures to the inhabitants of the vicinity, consideration was given to the procurement of a direct grant to be expended for labor and to be nonreimbursable and of sufficient proportion to make the project feasible for the balance of the construction cost. Since a direct grant of this size would be out of proportion to the population affected, the project was broken down into separate units for construction purposes, and an allotment, based on reimbursable and nonreimbursable funds, requested.

The Glendive unit was selected as the first to be constructed and on August 26, 1937, the President allocated $1,605,000 of E. R. A. money for construction purposes. The allocation specified that $829,000 was to be a direct grant to be expended for labor and $776,000 was to be expended for engineering and administrative employees and for materials and was to be reimbursed to the Government. These figures were later revised to $1,057,800 nonreimbursable, and $547,200 reimbursable. Construction of the unit was started on November 12, 1937, with the breaking of ground for excavation of the main canal. Construction of the irrigation system is now complete with the exception of priming and puddling work and the purpose of this article is to describe the principal features involved and the methods used in their construction.

The Glendive Unit

The Glendive unit lies on the west side of the Yellowstone River between Fallon and Glendive, Mont. It contains about 17,000 acres of irrigable land, 2,200 of which are located in an abandoned irrigation district and because of legal restrictions cannot be entered at present. In addition to the 2,200 acres there are 1,800 acres lying above the main canal for which relift pumps are planned in the future and 1,000 acres at the lower end for which no construction work has been done because of insufficient funds. Construction work at present is complete for 12,000 acres and the system is designed and constructed to sufficient capacity for furnishing water to all 17,000 acres when additional money is available for construction of the extensions and for additional pumping units.

The design of the system is based on a pumping requirement of 1 second-foot for 55 acres of irrigable land and on the delivery of a maximum of five second-feet to the high point of every 80-acre tract of land outlined by legal subdivision lines.

Construction of the system as specified in the allocation order of the President was to be carried on by Government forces under the direction of the Bureau of Reclamation. All labor was to be obtained from the W. P. A. rolls of the region with the exception of a 5- to 10-percent exemption for supervisory employees. In addition to this the employment of equipment owners on an owner-operator basis was allowed and paid for from the nonreimbursable fund. This procedure was followed throughout the duration of the construction period and completely provided for the relief requirements of the community and surrounding territory.

In the fall of 1937 the Bureau of Reclamation opened an office at Glendive and set up an engineering and clerical organization for directing construction of the project. In this office designs for the lay-out of the system and minor structures were prepared, as well as timekeeping, bookkeeping, and cost-keeping records.

Pumping Plant

The pumping plant is located on the bank of the Yellowstone River about 27 miles southwest of Glendive. It is designed to deliver 330 second-feet of water against a total dynamic head of 103 feet. The plant has provisions for the installation of three separate pumping units, each having a capacity of 110 cubic feet per second. Two of these units are now installed with the third unit to be installed at the time of the inclusion of the remaining irrigable lands. The pumps discharge through a steel pipe manifold into a single monolithic concrete discharge line which carries the water to the head of the main canal. Power for pumping is supplied by the Montana-Dakota Utilities Co. from their transmission line through a Government-built power tap line 1,100 feet long.

In the spring of 1938 a ¾-yard dragline was purchased by the Bureau and construction of the pumping plant was started in May, with the building of a gravel-surfaced road from the main highway to the site. This road and excavation for the main build-

Main canal excavation operations at station 630+00

ing, requiring a total of 18,700 cubic yards of excavation, was completed by the dragline in July and work on the building started.

The building is a concrete structure 25 by 54½ feet in plan and 64 feet high with an additional 32- by 41½-foot concrete inlet and trashrack structure. The first concrete was placed for the footings in September and placing operations continued through the winter until completed the following May. The building required 1,304 cubic yards of reinforced concrete and forms for concrete placing operations were built in the carpenter shop at Glendive and set in place by field crews. The principal difficulty during the construction, as in the case of all concrete work on the unit, was the inexperience of the construction organization. Very few of the carpenters and concrete men furnished by the W. P. A. organization were familiar with this type of work and a great deal of time was consumed in training and educating the men. They were willing and able to learn and an efficient construction organization was eventually built up. During the winter months, when temperatures as low as 40° below zero were recorded, the entire building was housed in a large tent and heating carried on continuously. In addition all concrete aggregates and the mixing water were heated before using. Construction during the winter, while ordinarily not desirable, was necessary on this project in order to keep the men from the relief rolls and also because of the desire to complete construction as rapidly as possible. Although the necessity of continued heating materially increased the cost of the structure, concrete placed in the building was sufficiently protected from the freezing weather at all times.

Siphon at main canal station 623+01 from inlet looking toward discharge

The two main pumping units installed at present are driven by 1,500 horsepower synchronous-type motors. Installation of the pumps and related operating equipment was completed in July. Under the specifications for the pumps an acceptance test was required, which test will be described further on in this article.

Directly related to the construction of the main building was the construction of an intake channel, a discharge pipe line, and a substation. The intake channel is an unlined earth channel 1,600 feet long from the intake to the pumping plant to the main channel of the Yellowstone River. Excavation for this channel was done with the dragline and consisted of 57,000 cubic yards of excavation. The discharge pipe line is a 7-foot inside-diameter monolithic-concrete pipe 600 feet long and connected through the walls of the main building to the pumps by 36-inch steel pipes. At the outlet end of the pipe is a 30-foot open transition to the main canal section and backflow down the pipe is prevented by an 84-inch automatic flap gate. Concrete work for the pipe line was started in February 1939, and completed in August 1939. Total concrete placed for the line was 546 cubic yards. The pipe was placed in 30-foot sections using removable forms set in place on concrete anchors.

For transforming the 33,000-line voltage of the Montana-Dakota Utilities Co. transmission line to 2,300 volts for operation of the pumping units a substation was constructed adjoining the pumping plant building. Three operating and one reserve 57,000/2,300-volt transformers with required bus structure and apparatus were set on a concrete foundation and enclosed in a high steel-mesh fence. The transformers were constructed for 57,000 volts in case the Montana-Dakota Utility Co. should increase the voltage of their line.

All of the work for the pumping plant and related structures, except a small amount of backfilling, painting, and general clean-up work was completed in September 1939. A temporary weir for testing the capacity of the pumps was constructed in the main canal just below the outlet to the discharge line and operating and testing the pumps was done during the latter part of September and in October. The tests conclusively showed that the pumps would not deliver the required amount of water and as a result the contractor for the pumps is now making alterations which will require new installations, to be tested before the irrigation season of 1940.

Since operation of the pumping plant will require the presence of a pump operator at all times, it was also necessary to construct a permanent residence at the plant site. A completely modern four-room frame house was constructed. This house is equipped with an individual water supply system from a nearby spring, all modern sewage and plumbing facilities, and it is likely that a wind charger may be installed for electrical service during the winter when the main power source will be cut off. There is also an all-metal three-car garage at the house and irrigation facilities provided for landscaping and gardening.

Main Canal

The main canal, as in the case of the pumping plant, is also designed for a sufficient capacity to supply water to the entire 17,000 acres of irrigable land in the Glendive unit. Starting at the outlet end of the discharge pipe line the canal properties are: base width, 13 feet; water depth, 7 feet; freeboard, 3 feet; 1½:1 side slopes, and a capacity of 330 cubic feet per second. The size of the canal changes at siphon sites, gradually decreasing, until at the lower end of the canal the properties are: base width, 4 feet; water depth, 2.6 feet; freeboard, 1.4 feet; 1½:1 side slopes, and a capacity of 31 cubic feet per second. This section is maintained at the lower end so that future extensions of the canal can be made to include the 1,000 acres of land not included in the present construction program. The total length of the canal is 31.3 miles and has a drop of 34.2 feet in water surface elevation from the beginning to the end. This drop includes 7 feet loss in head through the 10 siphons and the remainder from the canals average slope of 0.00016. No lining of the canal has been done and probably none will be required, although there are two gravelly stretches that may not be properly sealed by puddling and may require lining before successful operation can be accomplished. Structures along the canal consisted of 10 concrete siphons having a combined length of 4,215 feet, 4 wasteways, 5 United States Highway No. 10 bridges, 25 county road and farm bridges, 27 culverts under the canal, and a 2,700-foot stretch of canal having an average cut of 33 feet.

Excavation for the canal, 98 percent complete at the end of November 1939, was carried on by three methods. The principal method was by teams and scrapers employed on an owner-operated basis. An average force of 55 four-horse teams with scrapers, supplemented with plow teams and a 90 horsepower tractor with ripper, excavated 708,000 cubic yards of the 1,100,000 yards required. In addition to the teams, an owner-operated fleet of tractor-tumblebug units has excavated 225,000 cubic yards and the dragline has excavated 119,000 cubic yards. The remaining excavation will be completed by tractor-tumblebug and dragline methods. In addition to the canal excavation, there has been 86,000 yards of excavation from borrow pits for the construction of main canal embankments.

Siphon construction has been in progress steadily since July 1938. During the remainder of that summer and the winter of 1938–39 work was done on one siphon at a time but in the spring of 1939 and until completion in December of that year three

Placing concrete in Crackerbox Wasteway

Completed weir drop on lateral G19.3 R., station 11+50

siphons were under construction simultaneously. All siphon barrels were monolithic concrete, ranging in diameter from 8 feet 3 inches to 5 feet, and were placed in 30-foot sections with removable forms set in place on concrete anchors. A typical view of a siphon under construction is shown in the accompanying picture. Siphon construction required 56,500 cubic yards of excavation and the placing of 3,310 cubic yards of reinforced concrete. Five of the siphons located at regular intervals throughout the length of the canal, were provided with flashboard grooves in the inlets for diverting water into wasteways in case of breaks in the canal and also for checking purposes along the canal.

Four screw-lift vertical-gate type wasteways were constructed at the inlet end of four of the siphons. These wasteways required the placing of 305 cubic yards of concrete and are to be operated in conjunction with the flashboards in the upper ends of the siphons.

Drainage areas above the main canal and general topographic conditions required the construction of 27 culverts under the main canal. Twenty-two of these were concrete-box type, ranging in size from double 6- by 6-foot to single 3- by 3-foot, and the remaining five were precast concrete-pipe type. Culvert construction was completed in November 1939, and required the placing of 1,530 cubic yards of reinforced concrete.

All bridges constructed over the main canal were timber-type, constructed on timber piling for the five large bridges over United States Highway No. 10, and on concrete abutments and footings for the county and farm road bridges. These bridges were all completed in December 1939, and required the driving of 3,450 linear feet of piling, placing 280 cubic yards of reinforced concrete, and the erection of 276,000 board feet of timber.

Miscellaneous construction along the main canal consisted of a check at the lower end of the canal, 50,000 cubic yards of excavation for channels for bank protection, and placing riprap at the siphon inlets and outlets for bank protection.

Lateral System

The lateral system, designed to deliver a maximum of 5 second-feet to the high point of every 80-acre tract, required the excavation of 40 miles of comparatively small lateral canals. Because of topographic conditions, a large number of structures were required, all of which were concrete except the farm bridges. Road crossings for United States Highway No. 10 and county roads were constructed of precast concrete pipe. Construction of the lateral system was completed in December 1939. Excavation for the system was done by team methods and consisted of 104,000 cubic yards from canal sections and 56,000 cubic yards from borrow pits for embankment construction.

Structure work consisted of the construction of 43 main canal turn-outs, 8 lateral turn-outs, 169 farm turn-outs, 126 drops of both check and weir types, 55 checks, 15 weirs, 18 orifice measuring devices, 28 precast concrete pipe road crossings, 17 precast concrete pipe drainage culverts, 1 chute, 1 precast concrete-pipe siphon, and 27 farm bridges.

The farm turn-outs are a special design using an orifice gate and a regular turn-out gate so that water passing through the turn-out can be measured and at the same time loss in head through the structure is held to a minimum.

Telephone Line

Since there were no telephone facilities throughout the length of the unit and communication between the pumping plant and various points along the canal was necessary, a two-wire system was constructed. This line follows, in general, along the main canal and has phones located at the pumping plant, at all wasteways, at one side hill stretch of the canal, at the end of the canal, and at the warehouse in Glendive. It can be used only for communication between these points and is not connected into the regular phone system in Glendive or vicinity.

Concrete Aggregates

Sand and gravel used for concrete was produced by an owner-operated plant located on the project. The sand was somewhat coarse and a blending sand was also produced at a separate pit and blended with the coarse on about a 25- to 75-percent basis. Aggregates were dry batched at a batching plant located at the sand and gravel pit site and transported to the individual structures by trucks divided to hold mixer batches. Total aggregate produced included 5,756 tons of sand, 8,440 tons of fine gravel, 4,806 tons of coarse gravels, and 1,568 tons of blending sand.

Costs

The Glendive unit was the first construction work undertaken by the Bureau of Reclamation on a cooperative basis with the W. P. A. organization and little was known at the start of the job concerning what the costs would be. It has been proven that costs of construction on this unit were considerably higher than on other Reclamation jobs. This was due not only to the inexperience of the construction organization, but also to the methods used such as the great quantity of excavation done by team methods. Also it has been necessary to maintain a camp for the employees and although the men operated their own mess and were charged a nominal fee for living quarters, the camp did entail considerable cost to the Bureau. Also the necessity for keeping the men working during the winter months resulted in excessive costs for heating concrete and in the excavation of frozen ground. Additional cost, not ordinarily encountered under contract methods, was caused by the 130-hour law which makes it impractical to make field costs and overhead coincide as to periods of employment.

Future Work

In the spring of 1940 there will be a small amount of backfilling, riprapping, and clean-up work to be done. This will be completed in sufficient time for all priming and puddling operations to be undertaken before the irrigation season. Barring unforeseen difficulties, such as a requirement for canal lining, the system will be ready to deliver water to the entire 12,000 acres as required by the owners of the land.

Part of the unit will require a considerable amount of drainage work and additional funds have been requested for this purpose. This work will be done as required during the following years.

In addition to the construction work now completed, the development of the 2,200 acres in the old irrigation district and the 1,000 acres at the lower end of the canal, both mentioned previously in this article, is contemplated during the summer of 1940.

Allotments are now being made under the Great Plains Recovery Act and an allotment has been made for construction of a second unit of the Buffalo Rapids project. This unit extends from Shirley to Fallon, Mont., and construction is expected to start in 1940. Construction will follow the same general procedure in that funds will be allocated to provide supervision by the Bureau of Reclamation and labor from the W. P. A. organization. It is likely that horses will not be employed and construction will be carried on by modern methods. The Farm Security Administration will also have an allotment from the fund to be used for leveling the land and settling the project. The Farm Security participation in the development of the project is one of the provisions of the Great Plains Recovery Act.

Shoshone Fish Rearing Pond

WORK has been started on the construction of a fish rearing pond on the southeast shore of the Shoshone Reservoir. The pond, which is being constructed by CCC forces from Camp BR-87, is an ideal location, as it will be spring fed, and there will be an abundance of feed. It will be possible to transfer the fish raised in the pond to the reservoir without handling them by opening the gate in the dam. The pond will be planted with Mackinaw (Lake) trout and will be of sufficient size to raise approximately 100,000 fish each year.

This work should counteract any complaint by local sportsmen that fish will be killed by the draw-down of the Shoshone Reservoir next fall to permit the completion of the Shoshone Canyon Conduit.

The Recreational Development of Lake Minatare

NORTH PLATTE PROJECT

By R. B. BALCOM, *Senior Foreman, CCC Camp BR–1*

AN IRRIGATION reservoir in addition to being a storage place for water can be developed into a beautiful lake to be enjoyed by thousands of people living on or near the project it serves. Facilities can be provided for fishing, picnicking, and water sports. Lake Minatare, a Bureau of Reclamation reservoir on the North Platte project in western Nebraska, is an illustration of this type of development. This little lake is the only body of water approximately its size for a distance of 75 miles. When the lake is full, it covers about 2,500 acres, and has a shore line of nearly 10 miles. It is entirely a man-made lake; the ground it covers was originally the cow pasture of one of the early pioneers.

When Veterans Civilian Conservation Corps Camp BR–1 moved to the lake shore in the summer of 1934 it was a jungle of saplings and underbrush. The fertile sandy loam edging the lake had offered an ideal bed for cottonwood and willow seed collected along the hundred-mile canal which feeds it, but nature, in her planting, gave little heed to its development for the enjoyment of man. With the aid of the enrollees it became possible to remedy the matter. Although the activities of the camp were concentrated on the urgent work of rerouting and lining canals with reinforced concrete and the building of permanent water control structures, time was found each year for development of the lake area.

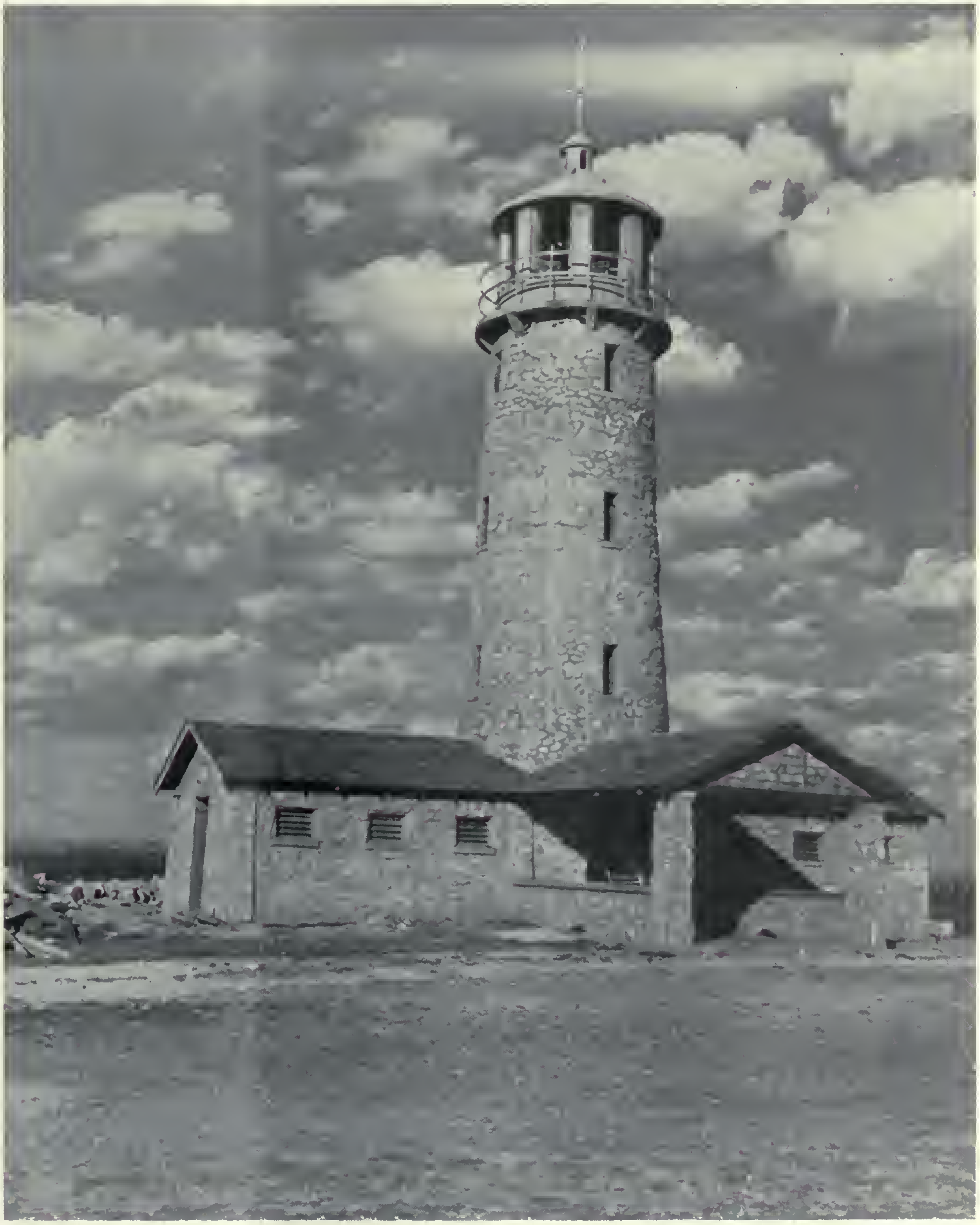
The first big job was thinning and grubbing. This made an ideal winter work program. By selection, the trees were thinned to leave the largest and healthiest and to give proper spacing. The undesirable species of willows were grubbed out to provide picnic areas.

Construction Program

Then came the construction work. A gateway of native rock was built to form an entrance for both camp and park. The main columns forming the portals are 18 feet high and can be seen for many miles on the main road leading to the lake.

A total of 23 rustic rock camp ovens were then built in various parts of the area to serve the many picnics, sausage roasts, fish and steak fries. More than 50 picnic bench and table combinations were constructed from pine poles and slabs. By the fall of 1936, two double toilets, a bathhouse for men and women, and two shelters had been built of native rock, quarried, cut, and placed by enrollees. One shelter contains a large room

Observation tower and bathhouse on shore of Lake Minatare



with a fireplace and rustic furniture, a kitchen equipped with a cooking range, donated by a citizen, and a smaller room for wood storage. A large covered porch flanks two sides of the building. A local civic organization sponsored this shelter and furnished all the roofing materials, partitions, doors, windows, and hardware. To obtain money for this, they put on a boat race and water carnival on the lake which 15,000 people attended. The register shows that 500 Boy Scouts alone have enjoyed an evening around the fireplace or have stayed all night in this cabin.

The latest of the native rock buildings has just been completed. This was designed to resemble a lighthouse and is located in an ideal spot for such a structure. It is far out on a point extending into the lake. The central unit rises 55 feet, and at its base are four rooms placed in the form of a cross. Two of the wings are used for bathhouses, and the other two are semiopen picnic shelters. The top or observation floor of the tower is reached by a circular reinforced concrete stairway. This floor has eight large windows from which a fine view of the lake and surrounding country is afforded. Two of the most famous landmarks of the Old Oregon Trail can be seen from the tower on a clear day, Scotts Bluff, which forms one side of the historic Mitchell Pass and is now a national monument, and Chimney Rock. These were mentioned many times in the diaries of the pioneers traversing the Trail on their way westward. One of the blacksmith shops of the Pony Express was located in Mitchell Pass. These formations are really not rock, but composed of brule clay peculiar to this region. Chimney Rock is several hundred feet high and is now noted for the Passion Play, known as the Chimney Rock Pageant, held in its shadow every year in June and attended by tourists from all parts of the United States, Canada, and other countries. The cottonwoods lining the North Platte River, at one time known as the Treeless River, can be seen by looking from the south windows. Along the near side of the river ran the Mormon Trail. On this section of the trail is the grave of the Mormon mother, Rebecca Winters. A great transcontinental railroad following in the footsteps of pioneers rerouted its original survey to keep from destroying her grave.

Wildlife Refuge

The entire Lake Minatare area is a bird and game refuge. Thousands of pheasants, several coveys of quail, cottontail rabbits, and many kinds of birds seek the protection of the areas left wild for that purpose. Each year thousands of ducks and several flocks of geese and pelicans rest on the lake during migration. In the fall migration, the ducks stay on the lake until it is completely covered with ice. Three kinds of gulls inhabit the lake during the summer.

A picnic area on the shore of Lake Minatare

Good roads have been built by the veteran enrollees to connect the developed areas. As the native trees are all cottonwood and willows, which are short lived at best, the men are now interplanting them with hardy hardwood species such as American elm, green ash, hackberry, ponderosa pine, and cedar, which are raised in nurseries operated by enrollees. Mulberries, plums, choke cherries, and grapevines have been planted to attract and feed the birds.

The areas immediately surrounding the permanent buildings will be landscaped with shrubs. Three wells were drilled this spring to furnish water to the visitors. It is not unusual on a pleasant Sunday to count 500 automobiles, some from as far as 50 miles away, enjoying the facilities developed by the VCCC camp. Picnicking, boating, fishing, swimming, hiking, camping, or just driving through the cool wooded areas offer pleasant diversions from work in a hot office or fields. The lake is visited by many tourists from every part of the country who drive through the North Platte Valley to visit nearby historical places such as Old Fort Laramie, Ash Hollow Hill, The Horse Creek Treaty site, where probably the greatest number of Indians assembled at one time to sign a treaty, the Pioneer Graves, and Register Cliff, where still can be seen the names of hundreds of pioneers carved in the soft stone, some as early as 1848.

The enrollee veterans are conscientious in their work and take great pride in what they have accomplished, as well they may. Lake Minatare park will remain as an enduring monument to the VCCC and to the Bureau of Reclamation Camp No. 1.

Each year more people take advantage of the facilities offered them at the park and many have complimented the camp on its work. Thousands of friends have been made for the Civilian Conservation Corps as a result of their development of an irrigation reservoir into a beautiful park.

EDWARD A. DACEY
1877-1940

E. A. DACEY was Chief Draftsman of the Bureau of Reclamation from June 16, 1934, to the date of his retirement for disability May 1, 1937. He came to the Bureau of Reclamation September 19, 1927, from the Department of Agriculture where he had served for 13 years in drafting positions. On the retirement for age of Chief Draftsman John H. Pellen, Mr. Dacey took charge as Acting Chief Draftsman, and 2 years later was appointed to the position of Chief Draftsman which he held at the time of his retirement for disability. He died of a heart ailment on March 12. A delegation of his co-workers was in attendance at his funeral.

He is survived by his widow who lives at 4228 Military Road NW., Washington, D. C.

Safety Diversion Tunnel and Shafts

Green Mountain Dam and Power Plant

By PAUL G. VAN SICKLE, *Senior Engineering Aide*

GREEN MOUNTAIN Dam and Power Plant are being constructed on the Blue River, 16 miles southeast of Kremmling, Colo. The dam is an earth and rock-fill embankment type with a maximum height of 270 feet above stream bed and crest length of about 1,300 feet. It will be the second highest and largest earth and rock-fill dam to be built in the country, exceeded only by the San Gabriel Dam No. 1 in California. The foundation bedrock consists of sedimentary rocks, either Dakota sandstone or Morrison shales, and intrusive porphyry. River diversion during construction is through a concrete-lined tunnel on the right abutment. This tunnel, 18 feet in diameter, will later be used for the reservoir outlet works.

The contractor arrived on the job December 1, 1938, and by the middle of December a temporary camp had been created to accommodate the tunnel workers, since driving the diversion tunnel was necessarily the first phase of the work to be accomplished. The camp consisted of a large building housing a commissary, store, kitchen, and two dining rooms, 25 eight-man bunkhouses, a time office, a compressor house, an oil house, a bathhouse or change house, and a toilet. A field office was constructed for the engineers, also an ambulance house, a blacksmith shop, and a powder-make-up house at the intake or upstream portal of the tunnel.

The diversion of the river marked the completion of an inlet approach channel, an 18-foot circular diversion tunnel, a 15½-foot circular inlet shaft (along with foundation for the trashrack structure), a gate chamber (to accommodate two 102-inch ring-sealed gates), a 20-foot diameter gate-hoist shaft, a 15-foot 9-inch by 23-foot 3-inch conduit tunnel (to accommodate two 102-inch diameter plate-steel penstocks and an outlet channel to be backfilled after completion of the power plant). The minimum thickness of the circular tunnel concrete lining is 18 inches and that of the conduit section is 24 inches. The thickness of the concrete lining of the inlet shaft varies from 18 to 24 inches. The lining of the gate hoist varies from 18 to 30 inches. The tunnel is 1,575 feet long and the lining in the circular section upstream from the gate chamber is reinforced. The 15½-foot circular inlet shaft is 90 feet in depth, while the 20-foot diameter gate-hoist shaft is 260 feet in depth (distance measured to invert).

On December 9, 1938, excavation was started at the upstream portal of the tunnel and the tunnel driven only from that end was holed through on May 25, 1939. On December 13, 1939, the tunnel and shafts were lined and grouted and the temporary cofferdam had reached sufficient height to divert the river.

Description of diversion tunnel and shafts

Linear feet tunnel driven	1,575
Vertical feet shaft driven	350
Cubic yards of excavation	30,000
Amount of pay roll	$174,000
Number of injuries	105
Number of disabling injuries	27
Days lost from injuries	18,311
Medical and compensation costs [1]	$24,822.84

The outlet tunnel was excavated in full section in Morrison shale to station 13+31, and in both Morrison shale and porphyry from stations 13+31 to 15+82 and entirely in porphyry from stations 15+82 to 19 + 18, the face of downstream portal. The sections at stations 12+28 and 13+31 were of relatively soft material (see Drawing 201–G–8). Approximately 70 percent of the length of the tunnel required the placing of steel ribs, and commencing at the upper portal approximately 100 linear feet of timber sections were placed. The 6-inch structural steel ribs averaged about 5 feet on centers for heavy ground and were supported by bearing plates or foot blocks set on a rock bench below the spring line. Drilling was done from a double-deck jumbo carrying six Leyner drills or drifters. An average of 52 holes were drilled per round. These holes, 8 feet in depth, were wet drilled and required one 4-foot starter, and one 8-foot length of second steel. The back and ribs of the excavation were kept well scaled and the heading operations generally were conducted with due regard for conventional safe practices. Daily inspection was made of the roof and sides of the tunnel and all loose material was scaled and removed. Also, after each blast was fired the affected locality

Circular section of tunnel, 18-inch diameter inside lining, looking downstream from outlet works and showing invert concrete placed around second curve of tunnel. Canvas covering protects fresh cement from loose material dropping from overhead and serves as safeguard to cement finisher from falling objects. All tunnel workers must wear hard hats

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[1] Estimated future costs (disbursements on tunnel accidents during year, $9,786.23).

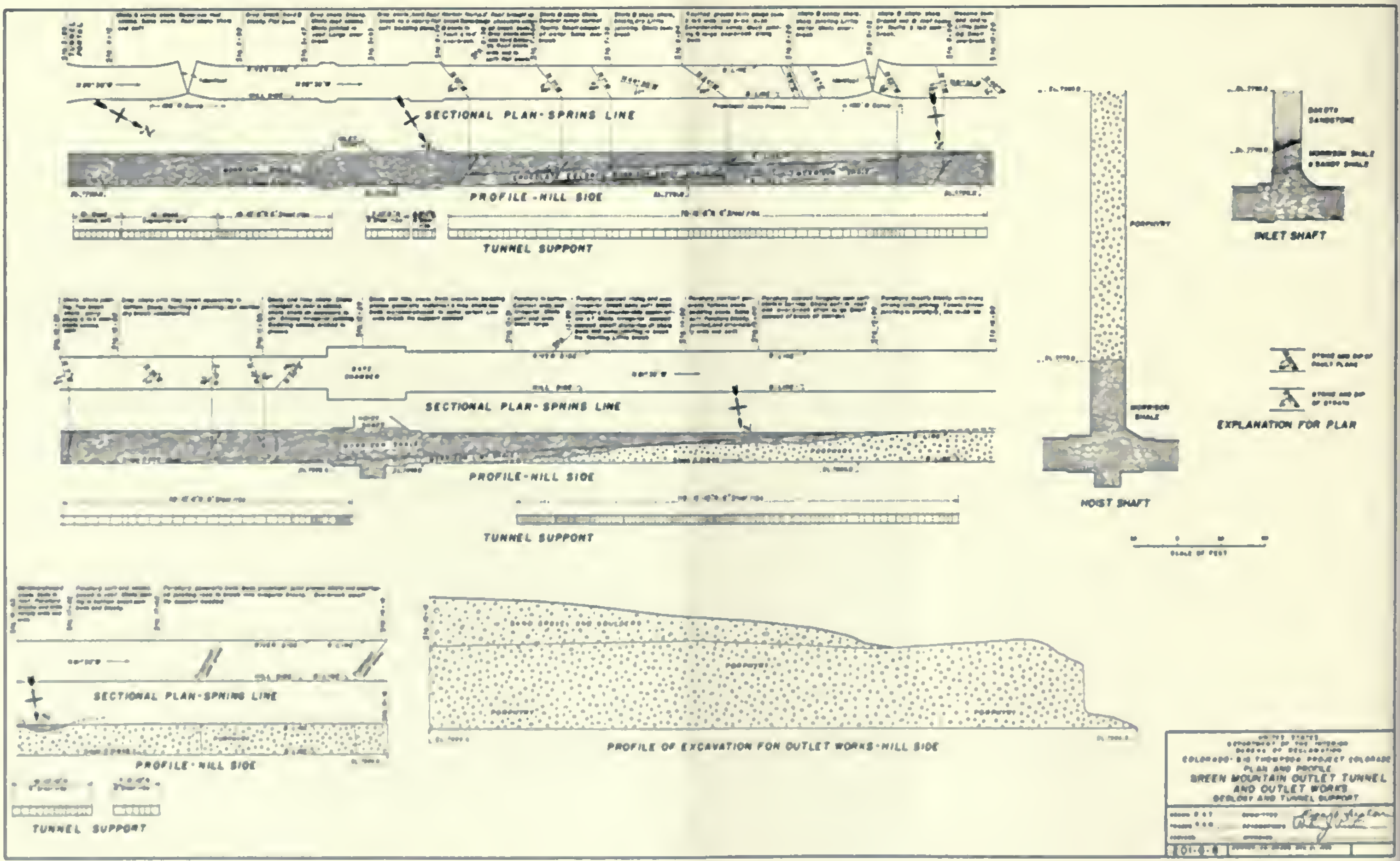
Looking downstream from above Green Mountain Dam. Contractor's tunnel camp in left foreground, portal of diversion tunnel farther downstream

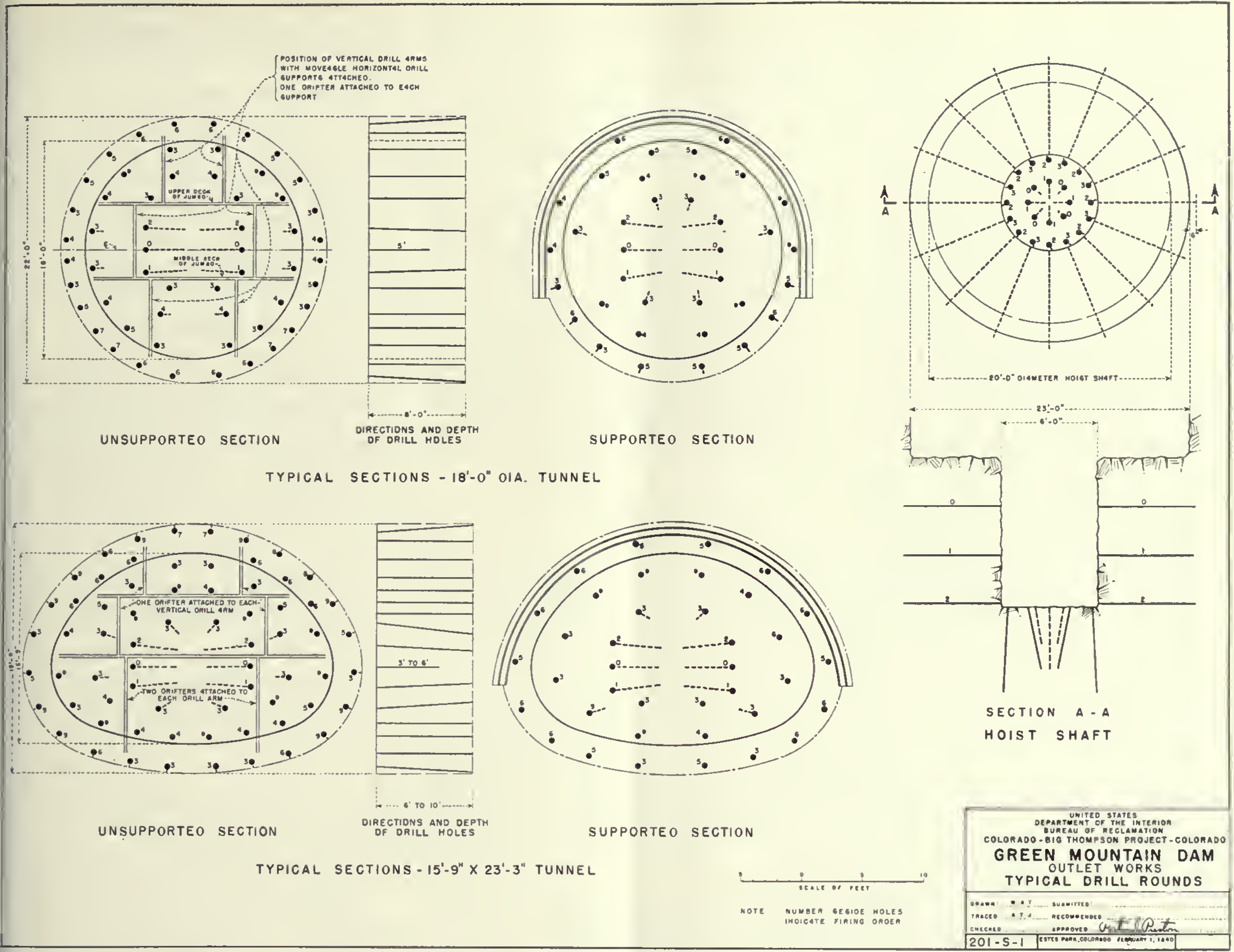
was thoroughly scaled and all loose materials removed. The wearing of safety hats in the tunnel was mandatory with everyone although this precaution did not entirely prevent the unusually high accident rate due to falling objects. The tunnel ladder and passageways and other working places were properly lighted. Lamp guards had extra heavy insulation and the lamps were placed in a position insuring ample clearance.

Electrical equipment was installed in conformity with local and State requirements, and underground wires were of the rubber-covered insulation type and switches of the enclosed safety type.

Gate Control Chamber Shaft

Operations at the gate control chamber shaft, except in a few instances, were well conducted from the standpoint of safety. The lowering of men was well regulated, and an employee was present at the top of the shaft at all times. An escape or auxiliary ladder was provided in the event of a hoisting failure. A 100-horsepower electrically driven tandem drum hoist with friction brakes and without overwinding or low voltage protection was used for hoisting men and material, with a 5-line sheave or block. On occasions it appeared that the load of the 2-cubic-yard concrete bucket was close to the braking capacity of the hoist, causing the brakes to get hot enough to smoke after a period of hoisting. At times it was necessary to hold the load with the brakes when reversing the


SECTIONAL PLAN-SPRING LINE
PROFILE-HILL SIDE
TUNNEL SUPPORT
SECTIONAL PLAN-SPRING LINE
PROFILE-HILL SIDE
TUNNEL SUPPORT
SECTIONAL PLAN-SPRING LINE
PROFILE-HILL SIDE
TUNNEL SUPPORT
PROFILE OF EXCAVATION FOR OUTLET WORKS-HILL SIDE
PORPHYRY
HOIST SHAFT
INLET SHAFT
EXPLANATION FOR PLAN
SCALE OF FEET
UNITED STATES
DEPARTMENT OF THE INTERIOR
BUREAU OF RECLAMATION
COLORADO-BIG THOMPSON PROJECT COLORADO
PLAN AND PROFILE
GREEN MOUNTAIN OUTLET TUNNEL
AND OUTLET WORKS
GEOLOGY AND TUNNEL SUPPORT


POSITION OF VERTICAL DRILL ARMS WITH MOVEABLE HORIZONTAL DRILL SUPPORTS ATTACHED. ONE DRIFTER ATTACHED TO EACH SUPPORT
UPPER DECK OF JUMBO
MIDDLE DECK OF JUMBO
22'-0"
18'-0"
5'
8'-0"
UNSUPPORTED SECTION
DIRECTIONS AND DEPTH OF DRILL HOLES
SUPPORTED SECTION
TYPICAL SECTIONS - 18'-0" DIA. TUNNEL
ONE DRIFTER ATTACHED TO EACH VERTICAL DRILL ARM
TWO DRIFTERS ATTACHED TO EACH DRILL ARM
15'-9"
3' TO 6'
6' TO 10'
UNSUPPORTED SECTION
DIRECTIONS AND DEPTH OF DRILL HOLES
SUPPORTED SECTION
TYPICAL SECTIONS - 15'-9" X 23'-3" TUNNEL
A
A
20'-0" DIAMETER HOIST SHAFT
23'-0"
6'-0"
SECTION A - A
HOIST SHAFT
SCALE OF FEET
NOTE NUMBER BESIDE HOLES INDICATE FIRING ORDER
UNITED STATES
DEPARTMENT OF THE INTERIOR
BUREAU OF RECLAMATION
COLORADO-BIG THOMPSON PROJECT-COLORADO
GREEN MOUNTAIN DAM
OUTLET WORKS
TYPICAL DRILL ROUNDS
DRAWN
SUBMITTED
TRACED
RECOMMENDED
CHECKED
APPROVED
201-S-1
ESTES PARK, COLORADO FEBRUARY 1, 1940

hoist. Such a combination was a potential hazard. Standard signals were used for raising and lowering material and workmen in the gate hoist shaft, an explanation of which was posted in the hoist room collar of the shaft, and at the underground station at the bottom. Special care was taken to keep electrical apparatus in good working condition and free from contact with other electric conductors. The following signals were used, which are considered standard for all shallow shafts:

One bell—stop if in motion, or hoist if not in motion.

Two bells—lower.

Three bells—men on, run slowly and carefully.

The use of buckets for handling men was permitted, even though dangerous. However, the number of men permitted to ride on one bucket was limited, and this rule was strictly enforced. Riding with tools and other material was prohibited. Tools, timber, or other materials were lowered in the bucket and securely fastened to the hoisting rope, which insured against the danger of striking the side of the shaft or coming loose from the bucket. The gate-hoist shaft entrance was equipped with the proper platform for landing of buckets and materials.

Mucking

The tunnel muck was loaded by a Sullivan "60" slusher into 4-cubic-yard trucks, Diesel operated. Ordinarily the complete cycle of operations, consisting of drilling, blasting, mucking, and timbering were completed in each shift. Under such conditions the trucks, four in number, averaged about 3 hours operation per shift. The job regulations required that the motors be shut off while the trucks were being loaded or awaiting turn underground. Question was raised regarding the use of Diesel-operated trucks underground, because of possible air pollution and consequent effect on the men. While such a practice might result in some hazard in the event of limited ventilation and inefficient operation of the motors (incomplete combustion) there was no evidence of these conditions. Ventilation was well maintained and the equipment kept in good operating conditions. Fumes were noticeable during the period of mucking out; however, they did not appear to be distressing, or particularly annoying.

Blasting

All rounds were electrically fired from a 440-volt blasting circuit carried on the opposite (right) rib from the power circuit. The blasting circuit terminated with a grounding switch at the portal, and was cross-connected to the blasting switch, located outside and on the left side of the portal by a portable safety cable, which was at the grounding switch. In lieu of a locked blasting switch, the fuse was kept removed and inserted only when, and immediately prior to, blasting. The miners loaded and connected their own holes—in series—and both the loading and connections were checked by the shifter. All circuits were tested with a galvonometer and the power and lighting circuits were cut out during the operation of loading and connecting up. Powder and primers were transported into the tunnel by truck, in separate containers. About 175 pounds of powder was used per round, and no surplus was kept inside. Proper precautions were taken to remove men from the tunnel heading when blasting was done in the shaft, likewise the men were removed from the shaft when blasting was done in the tunnel. An intermediate safety switch was installed in the blasting line about 300 feet from the heading. This permitted the shifter to make certain everyone was out of the danger area before pulling back to the blasting switch which was located around the curve in the tunnel, and, therefore, out of sight of most of the tunnel interior.

A total of 56,700 pounds of dynamite, mostly 40 percent, was used by the contractor in excavating the tunnel and shafts. In handling this powder three lost-time injuries were sustained in a single accident. Two of these were fatal, and the corresponding time of 6,000 lost-time days was charged for each fatality and 6 days for the nonfatal because of bruises of the back. This appears to be an exceptionally high accident rate for the amount of explosive handled under the conditions that existed on the work; however, the rate is the result of a single accident.

Powder Storage and Handling

Separate powder and cap storage was satisfactorily provided for in a locked dug-out magazine about one-quarter mile upstream from the contractor's camp area. Transportation to the job was by truck. From 1,000 to 1,500 pounds of powder, with a corresponding cap supply, was kept in a frame "make-up" house located along the construction road about 500 feet from the upstream portal and 75 feet from the engineers' field office. The make-up house was heated by forced draft through a metal conduit leading from a frame shed 20 feet distant which contained a heating stove.

Ventilation

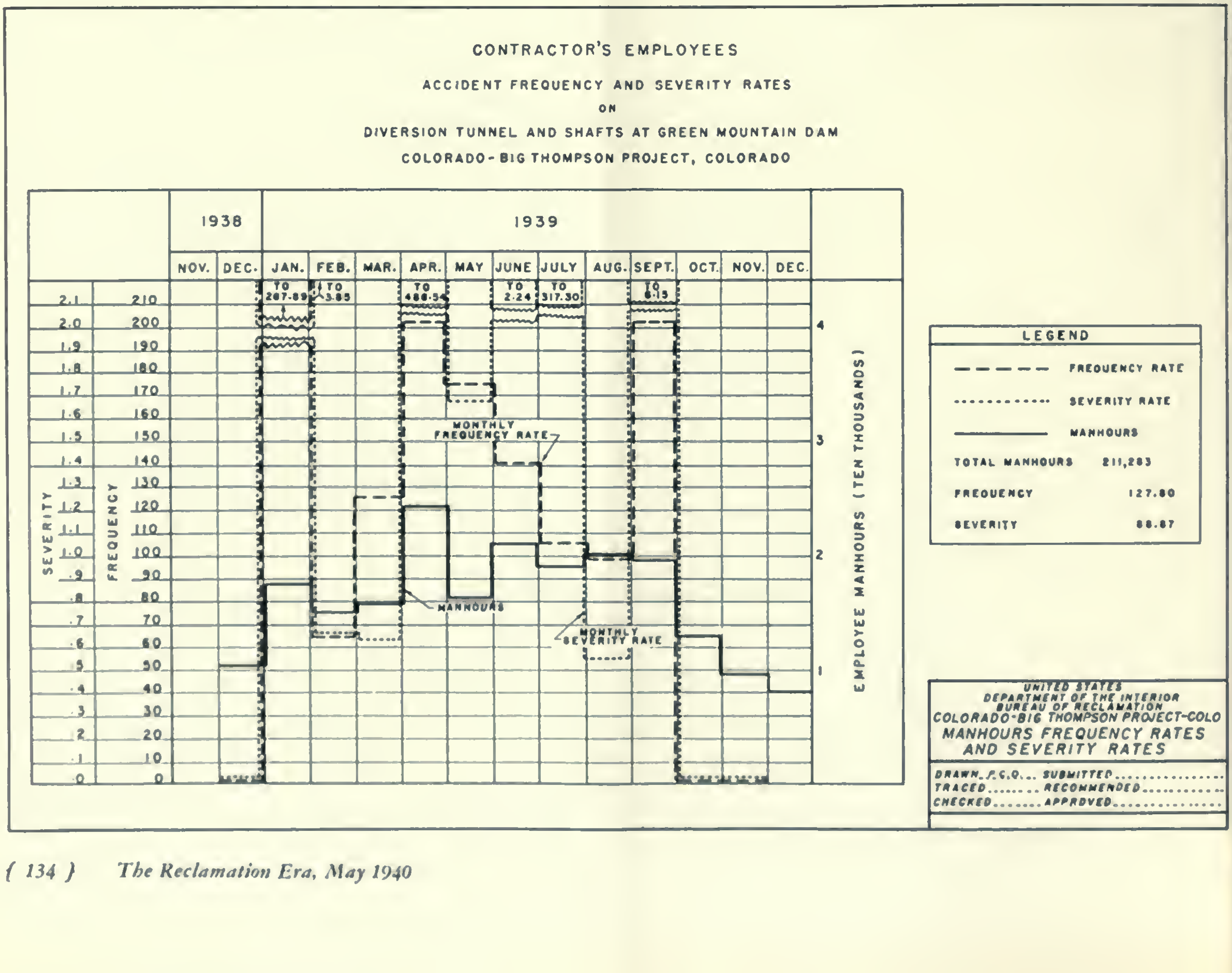
The tunnel ventilation was provided by an American pressure blower, V-belt driven, from a 15-horsepower electric motor, and delivering through a 22-inch diameter canvas tube, which was kept within 50 feet of the heading. While the blower operated somewhat below its rated capacity of 6,800 cubic feet per minute (for length of tubing up to 3,000 feet), there was a good supply of air. Care was given to maintaining the ventilating tubing free of folding or wrinkling and consequent loss of pressure and air volume. The ventilating current was kept in operation at all times even though there was some discomfort because of cold air at the face. The requirement that idle truck motors when loading or standing underground be switched off, was rigidly enforced.

Medical Facilities

Medical facilities consisted of a three-bed field hospital in charge of a resident physician. A completely equipped field ambulance was stationed in a frame garage near the upstream tunnel portal and was maintained ready for service at all times. All but one foreman and a number of the employees were certified first-aid men.

Summary

Safety practice has been highly developed in the manufacturing, mining, railroad, and



certain other industries during the past 20 years. Less progress has been made in the operation of heavy construction, with the result that almost unlimited opportunities exist for the development and application of practical accident prevention in that industry. To obtain good results, the support of the entire organization is necessary. Accident prevention requires the coordinated efforts of superintendents, foremen, executive officials, employees, and the safety engineers.

The diversion tunnel and outlet works of the Green Mountain Dam are similar to many others constructed by the Bureau of Reclamation and other agencies throughout the United States. The comparatively high accident frequency and severity rates experienced in tunnel-driving work, with few exceptions, are a challenge to the modern, economic-minded engineer. The increasing costs of these accidents are resulting in higher insurance rates to the contractors and consequently higher job costs.

The tunnel superintendent at Green Mountain Dam conducted his tunnel-construction operations with due regard to safety and efficiency. He was active in accident prevention and encouraged his men to apply for first-aid or medical treatment for minor injuries even though the injury was trifling. He required strict compliance with this rule. He made frequent inspections of all working places to insure that dangerous conditions were promptly corrected as far as possible and required the enforcement of applicable safe-practice rules.

Combustible material, insofar as possible, was kept clear of the shaft entrances. Oils and other dangerous flammable materials were stored in a frame structure maintained solely for such storage and located about 100 feet from the tunnel entrance. Combustible rubbish such as loose timbers, etc., was kept clear of the tunnel floor as far as practicable. Unlike many tunnels, the large size bore of this tunnel made it comparatively easy to keep the grounds clean even though a great amount of material was handled daily.

The contractor reported a total of 105 accidents on the diversion tunnel and shafts of which only 27 were lost-time accidents which included three fatalities. The causes of the 27 lost-time accidents were classified as follows: 6 falls of persons, 7 falling objects, 3 explosives (2 fatal), 1 electricity (fatal), 6 hand tools, 2 machinery, 1 vehicle, and 1 other. Employees' carelessness was the contributing factor of most accidents (56.6 percent). A few accidents might have been prevented if proper safeguards had been erected, the job kept clear of waste material, and more effort given to safety instruction on the part of the job foreman. Some of the careless and thoughtless acts of workmen which resulted in accidents, especially where they were engaged in heavy work and continually exposed to severe weather conditions such as existed in that vicinity, were due to the condition of their general health. Workmen who are suffering from severe physical ailments or even disorders of a minor nature are not only prone to accidental mishaps, but also they are unable to accomplish the same amount of work as the more healthy workers. Aside from the three fatal accidents mentioned above, the accident record was about the current average for tunnel work.

The direct cause resulting in a premature explosion at the tunnel heading was not determined. At the time of the explosion each crew of two miners was engaged in loading their own holes. The most plausible direct cause of the two fatalities seems to be the extra force applied in tamping the powder into the hole. A third fatality resulted when an employee was electrocuted when reinforcement steel which he was handling was placed in contact with the 440-volt power line. The deceased with three other employees was carrying one of the semicircular 1¼-inch bars for the lining reinforcement, which weighed several hundred pounds, into the tunnel. The men stopped for a short rest, set the lower part of the bar on the floor and leaned the upper section against the tunnel rib and the power line. After resting the deceased was the first to take hold of the bar, which, it is understood, he did with one hand while holding on to a steel support with the other. Either the insulation was poor or had been broken by the bar leaning against it or slipped while in contact with it, resulting in a fatal shock.

The Bureau of Reclamation organization in an effort to improve the safety conditions

(Continued on page 143)

COLORADO-BIG THOMPSON PROJECT

Accident classification record

LOST-TIME ACCIDENTS

Record by months from beginning to completion	Falls of persons	Falling objects	Moving objects	Handling objects	Stepping in or on objects	Striking against objects	Explosives	Electricity	Hand tools	Machinery	Vehicles	Other causes	Total injuries		Total days lost
													Disabling	Fatal	
1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
December 1938													0	0	0
January 1939		3								1	1		5	0	69
February 1939										1			1	0	1
March 1939	1								1				2	0	10
April 1939		1					3		1				5	2	12,018
May 1939	1	1							1				3	0	28
June 1939	2								1				3	0	48
July 1939	1							1					2	1	6,005
August 1939	1											1	2	0	11
September 1939		2							2				4	0	121
October 1939													0	0	0
November 1939													0	0	0
December 1939													0	0	0
Total	6	7					3	1	6	2	1	1	27	3	18,311
NO-LOST-TIME ACCIDENTS[1]															
													No time lost		
December 1938												1	1		
January 1939	1	1											2		
February 1939		4		1		1			2	4		4	16		
March 1939	3	4		2	1	3			4		2	2	21		
April 1939		7		1			3		2	1		1	15		
May 1939		1	2	2					2			1	8		
June 1939				1									1		
July 1939													0		
August 1939												1	1		
September 1939	2	1		1	1				2			2	9		
October 1939					1				1			2	4		
November 1939													0		
December 1939													0		
Total	6	18	2	8	3	4	3	0	13	5	2	14	78		

[1] Contractors' forces.

Total man-hours, 221,263; frequency, 127.80; and severity, 86.67. Frequency rate: Number of accidents per million man hours. Severity rate: Number of days lost per thousand hours worked.

Classification by Contributory causes

	Lost time	No lost time		Lost time	No lost time
	Percent	*Percent*		*Percent*	*Percent*
Faulty supervision	7.4	1.3	Physically unfit	0	1.3
Inadequate instruction	14.8	3.8	Defective equipment	3.7	3.8
Employee's carelessness	48.2	57.7	Disobedience to orders	0	2.6
Co-worker's carelessness	7.4	15.4	Other causes	0	2.6
No safeguards provided	18.5	11.5			

Irrigation History and Resettlement on Milk River Project, Montana

By GLADYS R. COSTELLO, *Malta, Montana*

MILLONS of years ago the foundations of present day agriculture and irrigation were laid in the Milk River Valley in northern Montana. Millions of years ago, when young and impetuous rivers roared down the precipitate slopes of the Rocky Mountains and cut through the alluvial fans left by the mighty mountain-born glaciers that had preceded them, the rich soils of the river valley were being planted.

In those days the Missouri River was a boisterous tyrant, carving its way northeastward to the Hudson Bay. It skirted the Bear's Paw Mountains down whose high and rugged cliffs tumultuous streams poured. Its deep channel swung east and north from the main range of the Rockies. Its waters were augumented by similar streams heavy with the silt of great plains of sedimentary deposits laid down in previous untold ages when inland seas lapped the newly risen mountains.

What manner of animals lived in that great period of time we may only guess. Perhaps it was during those ages that the dinosaurs, whose fossilized bones are now found in the eroded brakes of our streams, lived in the swamps of a semitropic climate. How long they lived we do not know. Geologists say at least 140,000,000 years and up until 60,000,000 years ago. Then began a slow change in the climate. Glaciers formed in the Arctic and slowly advanced through a hundred thousand years or more. Slowly, they came, covering what is now Canada and northern Montana along with States as far south as Illinois and Iowa. The great sluggish dinosaurs and other huge reptilian creatures, unable to adapt themselves to the increasing cold, perished before the steadily advancing ice sheet and their bones were buried in the congealing mud of the swamps.

Several times during a period of a million years, ice sheets crawled southward, receded, advanced again. The advance blocked the channels of the Missouri River, the Musselshell, the Yellowstone and Milk Rivers, and their tributaries. Acting as a dam, the glacier backed the water of the Missouri over the wide valley it had cut for itself. Its burden of silt was deposited in the channel and the valley until the old stream bed was filled in to a great depth. Still the ice sheet advanced until it had crawled to the edge of the Bear's Paw Mountains and almost completely surrounded the Little Rocky Mountains. Then the force of the great blocked river cut a new channel, usurped the channel of a preglacial tributary of the north-bound Musselshell River and, instead of the Hudson Bay, the Missouri sought the Gulf of Mexico as its destination.

Other millions of years passed and the ice sheet melted as the climate changed again. Only the Artic ice cap remained as a remnant of the glacial age. The plains over which the ice sheet had advanced and the hills it had leveled were scattered with boulders from the far north. Great deposits of gravel and vast morraines of debris were left as the ice melted.

The Milk River, a prehistoric tributary of the Missouri as it flowed north, sought a new channel when it, too, was blocked by the ice. Then as the Missouri was diverted to the south and as the ice sheet left the filled-in channel of the old Missouri, the Milk River, for some distance in northern Montana, preempted the channel of its mother river, then turned south as it again encountered the receding ice sheet and rejoined the Missouri on its journey to a new sea.

Because the Milk River now flowed through the wide valley carved by the Missouri and filled in by the damming of that stream, it had a fairly level valley to bisect. As it grew older and its early work of erosion was finished, the Milk River became a meandering stream subject to floods which caused it to overflow year after year, each year leaving a layer of silt from the burden it always carried and which gave it the name of "Milk" River when the white man came.

Origin of Indians Unknown

When or from whence the Indian came no one knows. How many prehistoric peoples had lived and died before the Indian no one knows.

An ancient legend of the Gros Ventres, one of the tribes of the Blackfoot Indian Nation, relates how one clan or village of their people was fishing on the ice far out from the shore of a great lake when the ice broke. Some were drowned and others fled to the opposite shore and so came to a new country from which they could never return because the lake never completely froze over again.

The new country, so the legend goes, was a more generous land than their own and the people thrived and multiplied until they spread over so vast a territory that the many clans did not know each other and came to speak different languages. Hunting and fishing were good and for many hundreds of generations they lived among mountains, lakes, and rivers. Then one chieftain, unable to agree with his fellow chiefs, led his clan into the unknown land that lay to the south and each year they followed the buffalo and antelope still farther south and as they traveled they found the buffalo more plentiful and the climate milder.

They were continually harassed by other tribes and because they were forced into war they became skillful in the uses of weapons. As nearly as can be estimated, it was about 300 years ago that these people reached the country of the "Big" and "Little" Rivers, the Missouri and the Milk.

They found others before them, the Shoshone or Snake Indians. And because they had become a tribe of warriors as a result of their encounters with many enemies and because in their southward journey they had come across an early outpost of the Hudson Bay Co., and had traded for a "firestick," which was an ancient musket, and a few rounds of ammunition they were able to defeat the Snake Indians and drive them into the West.

The people from the north, who called themselves the "Wind River People," found many strange writings on cliffs and boulders carved in the likeness of animals and, because they could not understand the writings and did not know the significance of the animals, they associated them with the supernatural and made sacrifices to them of meat and skins and pieces of their own flesh to propitiate the gods of the Snakes. Some of the old men of the tribe said these enemy tribes were all, at one time, part of their own nation and had come also from the north, but many years before.

This new country suited the newcomers. Here were high prairies abounding in buffalo and other game. Mountain streams were full of fish and lined with berry bushes.

Coming of the White Man

After many years of a pleasant nomadic existence, brightened occasionally by a skirmish with a warring nation, darkened at intervals by periods of drought when the prairie grass was scarce for the buffalo and the great lumbering herds drifted restlessly in search of food or when, as if forewarned, the buffalo fled to the south before the coming of a severe winter, strange, bearded white men began to appear on the rivers or with a party of Indians from a neighboring tribe to the east.

These white men made friends with the Indians. They married their daughters and built mud-daubed houses and long-trading posts, trading sugar and tea, whisky, firearms, and ammunition for bundles of furs. The sons and daughters of these white men and Indian women married and built themselves cabins. More and more white men continued to come up the rivers and by wagon train until in the sheltered bends of the Milk River and the Missouri, blue cottonwood smoke spiraled from chimneys and from the vents of Indian lodges and children played unafraid, for among those first white traders and trappers, the mixed bloods and the Indians there was peace and friendliness.

But more and more white men came each spring. Uneasiness grew among the chiefs. Rash young men made swift attacks on wagon trains. Army posts were established to keep Indians on newly formed reservations. Treaties were made with the chiefs and whisky and gayly colored calicos and blankets distributed to the people, who did not know they were signing away their homeland.

With the creation of reservations for the Indians a new class of white men came into the country. Cattlemen and then sheepmen established ranches and in a few years a railroad was built. At first a handful of stockmen ruled the open range, but in a few years they gave way to the increasing numbers of smaller ranchers who owned from 200 to 1,000 cattle and from 2,500 to 5,000 sheep. These ranchers settled on land in the river valley and along the larger creeks, and their ranges extended as far back in the hills as they could hold. Grass was plentiful on the prairie, but a home ranch near the railroad with plenty of good water was desirable.

It was during the early days of ranching in northern Montana that a series of hard winters was encountered. Feed had to be bought with money borrowed from banker or merchant at an exorbitant rate of interest. Even the high-priced feed failed to save the flocks and herds. For months, during the financial depression of the nineties, no trains ran on the railroad and food became scarce for men as it was for animals.

Practically every ranch was mortgaged. Few debts could be paid and in a few years the bankers and merchants owned the places. Increased herds of stock on the range to deplete the natural forage, years of drought and depression had ruined all but a handful of stockmen.

A few ranchers had plowed small fields and in good years were able to raise a little grain or hay and a garden. But recurring years of drought convinced them that some form of irrigation would be necessary if there was to be any future to the country.

Tenant farmer's family on undeveloped irrigated farm in Milk River Valley; land was purchased by Farm Security Administration

Water rights were secured on creeks and a number of ranchers laid out small irrigation systems. These with a few early flood control projects assured hay crops to the lower valley, or that portion between Harlem and Nashua in the Milk River Valley.

Beginning of Upper Valley Irrigation

In the upper valley, particularly that section lying between Chinook and Harlem, actual irrigation began in 1889 when T. B. Burns acquired the first water right on Milk River. Mr. Burns had come to northern Montana from the Gallatin Valley and was an experienced irrigation farmer. The establishment of the Fort Belknap Indian reservation in 1888 had left a great portion of the river valley open to settlement and among the new settlers were many who had been farmers.

In 1890 Burns and a group of nearby settlers constructed a brush and rock dam in the Milk River near the present site of the Fort Belknap diversion dam. This dam was maintained for 20 years.

It was soon apparent that the natural flow of Milk River, very low during the summer, would not be adequate for an irrigation project of any size. In 1891 E. S. Nettleton, Chief Engineer of the United States Department of Agriculture, conducted a reconnaissance survey of the headwaters of the St. Mary's River as to the feasibility of its diversion into Milk River. Nettleton indicated in his report that the project was physically and economically practical.

Ten years later, under authority conferred by an act of Congress to determine to what extent northern Montana could be reclaimed, Gerard Matthes made a preliminary topographic survey of St. Marys Canal. During this same year the Canadian Northwest Irrigation Co. completed the construction of a canal diverting from the St. Marys River about 7 miles north of the International boundary, for the irrigation of a large tract of land in southern Alberta.

Up to this time the irrigation development of the valley in the vicinity of Chinook was continuing under Burns and his associates. As the largest industry in northern Montana was stock raising, hay was the principal crop. More and more clearly was the need for more water demonstrated each year as the country became more thickly populated.

In 1901 C. C. Babb was employed by the United States Geological Survey to determine the most feasible method for the utilization of water from St. Marys River. In 1902 he reported that his investigations showed the most economical project would be the delivery of water from St. Marys River to the Milk River through the proposed St. Marys Canal, and transportation by river channel to the lower valley. A suitable agreement had to be made with Canada to protect the water supply from diversion throughout the 200 miles or more of river channel in Canada.

Preliminary work in connection with the St. Marys unit was continued throughout 1903 and 1904. By 1905 the rapid progress of Canadian irrigation activity created an urgent demand for the development of the St. Marys River project. On March 25, 1905, $1,000,000 of the reclamation fund, created in 1902, was set aside for construction of the canal if a satisfactory agreement could be reached with Canada.

Construction of St. Mary's Canal Started

During the year 1906 the preliminary work was continued and in 1907, an agreement having been reached with Canada, construction was started. During 1908 construction of the canal system for the irrigation of the lower valley between Dodson and Malta was started.

On January 6, 1908, the Supreme Court of the United States affirmed a lower court order which granted the Indians of the Fort Belknap reservation a prior right to all the natural flow of Milk River which could be beneficially used upon reservation lands up to a certain amount. This, during an ordinary season, is more than yielded by the river and its tributaries above the Indian project diversion dam. It was, however, a factor increasing the need for supplemental St. Mary's supply, both to care for the existing demand and to provide for future development under way.

In 1916 the St. Mary's Canal was finished, and the first water delivered to the Milk River for irrigation use was during the season of 1917.

The irrigation plan of the Milk River project provided for a storage reservoir at Sherburne Lake, since included in Glacier National Park, and its diversion through a 29-mile canal heading three-quarters of a mile below lower St. Mary's Lake and discharging into the North Fork of Milk River, thus supplementing the river's natural flow and that of other streams emptying into Milk River. Water is diverted from Milk River by dams near Chinook, Harlem, Dodson, and Vandalia.

The irrigation districts in Blaine County, cooperatively organized many years ago, hold early water rights on the river and because the natural flow is often extremely small, these districts, five in all, have contracted with the Bureau of Reclamation for additional water. Water for the Indian project is diverted by a dam on the reservation and water for the east end or lower valley, is diverted at the Dodson Dam. A south canal supplies lands on the south side of the river between Dodson and Strater and conveys water to the Nelson Reservoir, 20 miles northeast of Malta, for storage and diversion to the Saco and Hinsdale districts. A north canal supplies water for farmers on the north side of the river from Dodson to the east end of the Malta district. A dam near Vandalia diverts water into a canal on the south side of the river for lands near Tampico, Glasgow, Paisley and Nashua.

Original plans for the Milk River project included a reservoir at the site of the Chain-of-Lakes. Because of high construction costs this unit was abandoned.

Not until the winter of 1937, thirty years after construction was begun on the project, was the Chain-of-Lakes Reservoir incorporated into the system. The Chain-of-Lakes lies 3 miles northeast of Fresno and will require a dam to cost approximately $2,000,000. The Chain-of-Lakes probably marks the line of a pre-glacial channel of Milk River.

Construction of the Fresno Dam and the creation of the Chain-of-Lakes Reservoir, will not only supply additional water for the system, but it will help control the periodic floods of the river. The towns of Havre, Chinook, and Harlem will use water and the Utah-Idaho Sugar Co. has agreed to a contract for water. Success of the development plans for the entire valley depends directly upon this unit of the irrigation system.

Land Prices Increase

In the early days of construction on the Milk River project and the assurance of the completion of the irrigation system, land prices rose steeply. Ranchers who had heretofore depended upon range grass the year around, began to buy up large tracts of the valley land. Rangers were rapidly becoming overstocked and they realized that some provision for winter feeding would be necessary within a few years.

Typical rural school in Phillips County. The children are from families of dry-land farmers

Speculators were encouraged to invest in Milk River land, obtaining tracts from the local banks and businessmen who had been burdened with land since the early settlers had first started borrowing. By the time the irrigation project was completed few of the original settlers were still on their own land.

Development of the valley lands, even with the completion of the irrigation system, was retarded to a great extent by the homestead era when a free home on the vast, unplowed prairies was infinitely more attractive than the higher priced irrigated land.

Dry-land farming completely overshadowed irrigated farming. This, combined with the fact that the larger part of the irrigated tracts were unpatented and that patents would not be issued to the owners thereof until construction charges of the irrigation system were determined and arrangements made for their payment kept many persons from developing irrigated tracts. As a result of the nonissuance of patents, there was a considerable period of time when county taxes could not be levied against the property. Irrigated land upon which taxes were not levied and upon which construction charges had not yet been assessed, made cheap hay land for the stockmen who were still interested mainly in raising feed.

Scattered tracts of patented land paid taxes, but the owners of these tracts, usually businessmen who regarded their land as an investment or ranchers who needed winter pasture, paid their taxes without thought of developing their land to the point where it would produce enough crops to pay its own taxes.

Although it was not at once apparent, it soon developed that the dry-land farmers and the ranchers were working at cross purposes. The homesteader by filing on submarginal range land was ruining the future of the stockman, and the stockman, who owned the valley land which he did not cultivate, was preventing the farmer from settling on the only land upon which he could make a living.

The situation, due to the earlier development of irrigation farming, differed somewhat in the Blaine County end of the project. There most of the land was patented and irrigated by private projects. As the original owners died, moved away, or retired, the tracts were subdivided and rented. In Blaine County, as a result, there are considerably more tenant farmers than in the Malta or Glasgow district and the land is more highly developed.

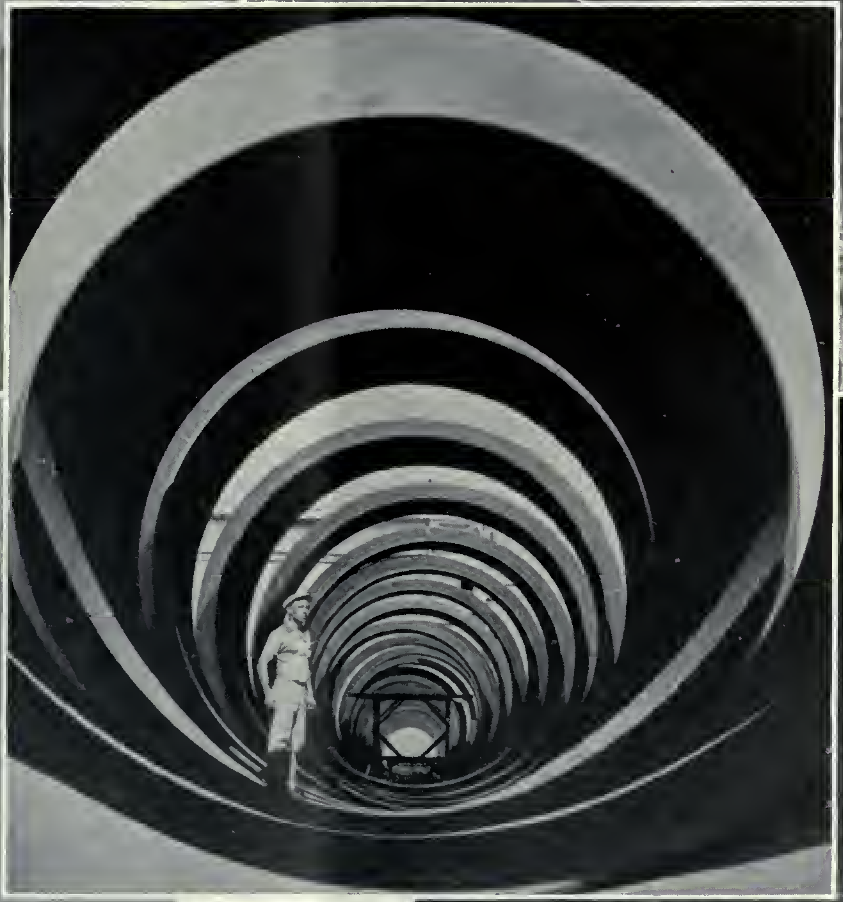
In 1928, a few years after taxes were first levied against unpatented land, the farm population of the Milk River Valley was 1,525. Of this number 776 lived in Blaine County, 521 in Phillips County, and 228 farm

(*Continued on page 142*)

THROUGH OUR CAMERA LENS

Arch 8, Bartlett Dam

Inlay in this cavity will be Friant Dam, the fourth largest in the world



Pipe sections made of 16,000,000 lbs. of steel plate to be stitched together with 83 tons of welding rod, will line the penstock tunnels leading to the Grand Coulee power plant

Continuous Burning to Eradicate Noxious Weeds

By C. L. CORKINS, *State Entomologist, and* A. B. ELLEDGE, *County Pest Inspector, Powell, Wyo.*

IN THE January 1940 issue of the RECLAMATION ERA brief mention was made of the use of continuous burning for noxious weed eradication. Since this method seems to have a practical appeal to many people, especially farmers, and numerous questions have been raised about it, an enlargement upon the subject seems desirable.

Continuous burning is still in the experimental stage, but it offers hopeful prospects of becoming cheaper and more practical and efficient than the chemical methods for small patches of weeds under certain conditions. As yet we are only sure of our ground in saying that it is a better eradicant than chlorate on White Top, *Lepidium draba*, and Canada thistle, *Cirsium arvense*. It will kill other noxious weeds, but refinements in our methods will have to be made before it will be cheaper than chlorate on bindweed and Russian knapweed. But refinements are possible, for this method is new and our experience yet very limited. Our test work was started in 1937. Extensive field operations were started for the first time during the spring of 1939. No fundamental research has yet been made and such important questions as (a) the longest possible allowable interval between applications, (b) the best time to start treatment, (c) the proper time to renew treatment the second year, and (d) the exact optimum degree of burning are yet incompletely or wholly unanswered. So it is hoped that this article may not only stimulate practical trials elsewhere, but also initiate research.

When the test plots were inaugurated in 1937, it was thought that continuous burning might work very much like continuous cultivation by depleting the starch and sugar reserves in the root system and by preventing their manufacture in the leaves of the plant. As a consequence, we started by completely burning the plants down to the ground, which was referred to by the workmen as a "tight burn." The reaction of the plants was very similar to a clean cut by a tool at the surface of the ground. In a day or two, new growth "popped" right up and they quickly reestablished themselves. A 10- to 14-day interval seemed to be as long as could be left between treatments. The regrowth was so rapid and persistent the first year that we became a bit discouraged with the project. This continued until midseason the second year and then results began showing up rapidly. None of the test plots which showed complete eradication has ever since produced any signs of return of weeds. However, the necessity of such frequent treatments made the method doubtful as to practical value. And then one of the county pest inspectors reported the unusual results of an entirely accidental experience. Herein lies a little story of stumbling onto an important fact, which has its counterpart in much of the history of progress.

John Hendreschke, county pest inspector of the Eden Valley, Wyo., was burning a patch of bindweed which had developed mature seed. The growth was heavy and thick and John was doing a good job of burning it all up. In fact, he was doing such a good job that by the time it was half done, his burning fuel had been three-fourths used up. So it was a matter either of making a long trip after more fuel or taking a chance on getting the job done with a rapid, light burning. He chose the latter and proceeded to quickly sear the tops of the plants on the rest of the patch.

John got his surprise when he went back to treat this patch the next summer. The part which he had given a "good job" of heavy burning seemed to have been stimulated by the treatment and the growth was heavier and ranker than before. The part that he had given the "poor job" of light searing of the top foliage was thinned out at least half and the remaining plants were sickly and weak.

The burning method is especially applicable to the individual farmer's use, as the only important cash item of expense is the fuel

The Searing Process

Thus John Hendreschke became the father of the light searing process, which has led the way to the practical application of the burning method. In treating 889 patches of weeds at Powell last year, aggregating 18½ acres over a 101-mile route, the intervals between burning were lengthened out to 3 to 5 weeks, and none had more than 5 treatments. And the results were far better than with twice as many applications of the tight burn.

It seems that there is some action produced by the light sear besides starch starvation. After treatment, the roots die down into the ground several inches and the plants have a physiological set-back. Just what the action may be is not known. When the deeper roots start dying, they appear as dessicated as if they had been dried out in a hot oven. They look entirely different from the dark brown decayed roots, which have been beset with bacterial rot, produced by continuous cultivation.

The first burning is given at the pre-budding stage in the spring. This is when the starch reserves are the lowest and the roots in the poorest condition to stand a shock. Whether it is safe to let the plants regrow this long before a second treatment is given is not known. We take no chances and sear them again a couple of weeks ahead of the pre-budding stage. It is believed there should be a fair amount of foliage always present to sear. The plants are allowed to reach the pre-budding stage again the second spring of treatment before burning is started.

With this method, as with continuous cultivation, there is a wide variability, even on a given weed species, in their resistance to treatment. It is impossible to predict just how long it is going to take to kill a patch of weeds. During the 1939 season of initial treatments, when 5 burnings were given from May to October, 43 plots were eradicated, 267 more than 90 percent killed, and the balance of 579 showed definite signs of weakness. It is indicated that the average number of burnings required will be about 8 or 9 over a 2-year period for White Top and Canada Thistle. Some will doubtless require more treatments and a few will probably take 3 seasons to completely eradicate. There has been one very prominent factor of variability noted. Weeds on dry areas react more quickly to burning than those in moist or wet situations. This may be correlated with volume of root system, but such does not yet appear to be at all certain.

We now feel very hopeful about one important experience with the burning process, namely, that when eradication is indicated as completed by no return growth over a season's period, eradication is really an accomplished fact. Surface readings of results apparently tell an accurate story. Such is not the case with the chlorate method, for it has been our sad experience that regrowth shows up too frequently when the job was thought completed. Re-treatment of chlorated areas often drives the cost of this method two to three times as high as the initial treatment. One cannot be sure for several years after no new growth has come up that a chlorated weed patch is eradicated, and at times we are doubtful if one ever can be sure.

The lay-out of the plots for a burning job is exceedingly important. An entire unit of infestation must be completely treated. If one burns only part of an infestation, it will be found that on the edge next to the untreated area, unharmed roots from the untreated plants will grow underneath and into the treated area at least 6 feet a year. So if burning is being used along a fence row or ditch bank adjacent to an infested field, it is imperative that the field be treated by continuous cultivation at the same time.

A 3-horsepower spray pump operating 1 to 3 burners and spraying 5 to 6 gallons per minute

Cost of Eradication

Unit statistical data on field operation can be based on only the one initial year of experience we have had so far. This was under public operation in a pest district, where all cost factors had to be considered and the project placed on a large scale of operations over a wide area. Large power equipment, which is described later, was used. An average of 0.95 gallon of burning oil was consumed per square rod. With refinement in the burning equipment, this was cut to 0.42 gallon per square rod for the last treatment. The total average time required per treatment per nozzle per square rod was 6.4 minutes. It is estimated that loss of time in moving the equipment between patches and the making of records accounted for at least half of this time. One man can and should actually light sear a square rod in 2 to 3 minutes. The average cost factors per square rod per treatment were: Labor, 5 cents; burning oil, 2½ cents; machine and mileage, 2 cents and administration 1½ cents making a total of 11 cents. If the number of applications necessary is 8, the total cost of eradication would be 88 cents per square rod.

This method is especially applicable to the individual farmer's use, as the only important cash item of expense is the fuel. The necessary equipment is cheap, as a home burning outfit can be rigged up for $15 or $20 and may and should be used for other purposes, such as burning annual weeds in waste areas and spraying the garden and orchard. Thus, if this method of eradication is put on a cash outlay basis for the individual operator, it will run only about 16 to 20 cents per square rod for eradication.

The equipment is designed to burn a very low-grade fuel. Perhaps the most satisfactory fuel is furnace oil, which costs 4 cents per gallon in our area and is generally cheap in the Western States. The more common fuel used in Wyoming is refinery bottom refuse, which is ordinarily a waste product of small cracking plants and runs from 28° to 38° Baumé. To the lower grades is added from 5 to 10 percent distillate to thin it and raise the flash point. This product usually sells at about 2 cents per gallon. Our experience indicates that it is very little cheaper than furnace oil, because it does not completely burn up and more is used per unit area. Some feel that the residue left on the foliage from the use of this oil may be of herbicidal value, but this is doubtful.

This fuel is burned by running it through a pressure spray pump at 75-pound pressure for the furnace oil and 125-pound pressure for the refuse. The burning gun is merely a 12-foot ¼-inch iron or copper alloy pipe, with a Chipman or other spray gun cut off at the operator end and a ³⁄₆₄-inch Chipman weed disk in the flame end. A loop is placed in the rod at the flame end in order to preheat the fuel with its own flame before it is ignited. This loop should be constructed so that the oil is thoroughly heated, *but not vaporized.* It is important that the Chipman type of disk be used, as it will throw a broad, flat flame that cannot be secured by any other type. It should also be pointed out that extensive trial has shown that the size of the disk outlet cannot be smaller than indicated and a larger one will simply waste fuel.

Three types of spraying equipment are used to meet varying conditions.

1. The junior size model, 2 horsepower, high pressure spray rig is adaptable to public programs, and will easily run two guns. Larger equipment is unnecessary. This rig is mounted on a truck, and is particularly

An infested area 3 weeks after searing. Note the standing foliage killed by the light searing. Little regrowth is yet in evidence

adapted to use on roadsides and dry waste areas. This outfit can be rigged up for about $300, without truck.

2. A light power spray rig with a ½-horsepower air-cooled motor, mounted on a rubber-wheeled light trailer and drawn by a single horse, is best adapted for public programs on irrigated farms and waste areas inaccessible to the truck equipment. The wheel mountings of the trailer should be adjustable, so that the rig can be taken through row crops without damaging them. This is a one-man outfit and can be made for about $100 complete.

3. The hand orchard type of sprayer is cheap and handy for the individual farmer. The pump may be mounted on a steel drum and constructed complete for not more than $20.

Of course the common generator types of burners may be used, but they are both slow and dangerous to operate. We have eliminated them as being entirely impractical.

The degree of burning of the foliage of the weeds is so important that it should be reemphasized in closing. The flames should be passed rapidly over the tops of the plants so that they are so lightly seared that they will not wilt until the next day following treatment.

A 1937-38 test plot of the burning method for eradicating White Top. No regrowth has appeared and no live roots were ever found in many deep diggings

Irrigation History on Milk River

(Continued from page 138)

families in Valley County. In the Chinook district 499 families were engaged in farming, in the Malta district 268, and in the Glasgow district 153. There were more renters in Blaine County than owners and more owners than renters in either of the other two counties.

First Milk River Irrigation

The first actual delivery of water to the first unit of the Dodson south canal was in 1912, when 351 acres were irrigated and a revenue of $3,631 obtained. In 1917, when water was delivered to the completed project for the first time, 8,780 acres were irrigated and a crop report of the United States Reclamation Service shows a revenue of $47,548, or a little more than $5 per acre.

Although the construction of the Milk River irrigation system has been accomplished, development of the valley lands has not gone forward as had been anticipated. In the first place not much more than 20 percent of the land was irrigable. It needed leveling and draining before it could produce, and in the second place, it was held largely by stockmen owners who were not interested in farming the land but held it only as a safeguard against hard winters and dry seasons when range grass could not support their cattle or sheep.

In 1939 there were 691 farms irrigated in the Milk River Valley and crops produced were valued at $1,181,583.03. This was 3 years after the first dry-land farmers were resettled on irrigable farm units.

As a direct result of the assessment of taxes against hitherto untaxed land, the owners around the year 1928 began to realize that their expensive lands must be made to pay. A picture of the Milk River Valley at the time would have revealed thousands of acres of potentially productive land covered with rose bushes and buck brush. Down fences crisscrossed the fields and bands of half wild horses and range cattle drifted down from the hills to graze and find shelter and water at the river during winter months. More developed holdings yielded a crop of alfalfa hay.

Along about the first of June a couple of "hands" from the home ranch were sent in to irrigate the hay land. A shovel and a saddle horse were considered adequate equipment and fields that could not be irrigated by "wild flooding" were ignored. Seldom more than half of the farm could be irrigated. The low spots filled and became breeding grounds for countless mosquitoes until the water evaporated and the holes became soured "hard pans." But a sufficiency of hay was produced for the needs of the landowner-rancher.

[Continued next month]

A SOUND FILM, "Weeds," released this month by the Bureau of Reclamation, presents the case against weeds on the farm and shows practical methods of combating weeds on irrigated land.

Illustrating the source and spread of weeds, daily in view of farm owners but too often taken for granted, the motion picture stresses weed prevention as the cheapest and most practical control method. It depicts points of attack to prevent weed infestation that will save the farm owner and the community large expenditures of money in later years.

Losses from weeds, including the hazard to livestock and people of poisonous varieties, frequently widespread along ditches and drains, are presented. The high cost of growing weeds on irrigated land is shown by animation illustrating how weeds consume enormous quantities of water.

Scenes from many irrigation projects show practical methods developed in recent years to stamp out weeds. Here are shown the latest methods of eradicating weeds on ditch banks and permanent control measures to keep weeds from regaining a foothold, once they are driven out. Especially interesting are pictures of the timely searing method which gives promise of lowering costs of killing such damaging weeds as white top, Canada thistle, and poisonous water hemlock. Also shown are the use of chemicals as herbicides, including the wet and dry applications of sodium chlorate and the latest methods of applying carbon bisulphide. The shoot-cutting method to eradicate long-lived perennials, also known as clean cultivation, is demonstrated for large areas. Emphasis is given to those practices that field tests have proved give best results under irrigation.

The film is available to project superintendents, county agents, agricultural instructors, and groups interested in weed-control work. It may be obtained only in 16-millimeter sound edition, requiring a 16-millimeter sound projector for showing. Running time is 20 minutes. Requests for the film should be addressed to the Commissioner, Bureau of Reclamation, Washington, D. C.

William H. Trimble
1885–1940

WM. H. TRIMBLE, Chief Ranger of the Boulder Canyon project, died the evening of May 2 at Boulder City, Nev. He was born at Cheyenne, Wyo., and his legal residence was Colorado. With the exception of two periods in 1920 and from 1922 to 1933 he served continuously with the Bureau of Reclamation from 1918 to the date of his retirement for disability February 7, 1940. Mr. Trimble is survived by his widow and a married daughter.

Robert F. Skinner
1891–1940

ON April 20, 1940, Robert F. Skinner, employed as engineer on the Friant Dam of the Central Valley project, died suddenly of a heart attack just outside of the Government office at the dam site.

Engineer Skinner served the Bureau of Reclamation for 13 years, starting in 1927 as ditch patrol on the Yakima project, and serving as inspector, assistant engineer, associate engineer, and full grade engineer on the Kittitas and Roza divisions of this project, the Taylor Park Dam in Colorado and Boulder Dam.

Word reaches the Bureau that he is survived by his widow and two sons living in Seattle.

Safety Diversion Tunnel

(Continued from page 135)

on the tunnel operations emphasized the necessity for correcting definitely apparent hazards rather than placing too much accent on general safety. Effort was made to convince the contractors of the importance and value of accident prevention and the fact that safety and production go hand in hand. The up-to-date employers realize that favorable accident records mean low compensation rates and a careless disregard for accident prevention means correspondingly high rates. This is true not only for the large operator but also for the small operator; each pays an accident compensation premium on his total pay roll. Rates paid for compensation insurance are assessed on the basis of past accident records. That is, the rates are established as a result of the value of the claims made on the insurance company to pay for the accidents sustained by the employees of that company. The Government is properly concerned with high accident costs to the contractor because in submitting bids for work which he proposes to perform he must protect himself by submitting a higher bid than would otherwise be possible.

Porter J. Preston is supervising engineer of the Colorado-Big Thompson project. S. F. Crecelius is construction engineer in charge of construction of Green Mountain Dam and power plant, with R. B. Ward, field engineer. The general contractor is the Warner Construction Co. of Chicago, Ill., for whom Frank J. Kane is tunnel superintendent, and Walter N. Hill, chief engineer.

D. A. Club of Reno

THE officials of the Reno, Nev., branches of the Department of Agriculture have formed what has been termed the D. A. Club, a feature of which is a luncheon meeting held at a local restaurant on the third Tuesday of each month for the purpose of creating cooperation and understanding between the various branches and agencies of the Government service.

F. M. Spencer, acting construction engineer of the Truckee storage project, attended the luncheon on March 19 upon invitation of Government officials interested in land-use activities.

Origin of Names of Projects and Project Features in Reclamation Territory[1]

Colorado–Big Thompson Project, Colorado

THE HISTORY of this region is written in the names upon its maps, and suggests the important parts played by Spanish explorers and Spanish American settlers, by French, English, and United States trappers and Indian traders by miners and pioneer leaders in town building and in government. The story of the naming of the towns and physical features of the area included in the projects abounds in romantic interest. Some of the most attractive and distinctive place names of the area were given by the Indians who generally made use of phrases descriptive of the landscape and commemorative of some event that took place in the vicinity. Also the early Spanish settlers took care that their mother tongue should be well represented on the map. However, the majority of the place names of towns have been named for pioneers from the eastern part of the United States. There are a few names of French origin which indicate the lesser heritage from France. The Anglo-American names are reminiscent of the period of exploration and the days of the trapper, while the colorful days of the gold rush and the active days of prospecting, and early mining on the Western Slope have left typical names seasoned with humor and tragedy. Only a few town names recall the prehistoric inhabitants of mountains, parks, and plains now included in the area of the project, for early explorers substituted Spanish or English words for most of the Indian terminology in use and the early settlers had little inclination to borrow from the strange languages of the Red Man.

Counties

The project works are located in Summit, Grand, Larimer, and Boulder Counties. The area to be served by water from the project includes Larimer, Weld, Boulder, Morgan, Logan, Washington, and Sedgwick Counties. As the names of towns, streams, and mountains of the area included in the project reflect the story of exploration and settlement, so the description of counties reflects the development of the region, indicating the time of settlement of various sections and faithfully reflecting the periods of growth.

Larimer County (1861) was named in honor of Gen. William Larimer, a founder of Denver and prominent pioneer of Colorado.

Morgan County (1889) took its name from Fort Morgan. The original fort (1865–68), established as a protection against the Indians, was first called Junction or Camp Wardell. In 1866 it was officially christened Fort Morgan in honor of Col. Christopher S. Morgan who died that year.

Sedgewick County (1889) was named from Fort Sedgewick (1864–71). This military post, located across the river from present Ovid, was christened in honor of Gen. John Sedgewick, who had led Indian campaigns into the regions of Colorado in 1857 and 1860 and was killed in battle in 1864.

Summit County (1861) was so named because of the mountainous character of its territory. The eastern boundary of the original county followed "the summit of the snowy range" (October to November 1, 1861) from a point a little south of Breckenridge to the beginning line.

Washington County (1889) took the name of President George Washington.

Weld County (1861) was named in honor of Lewis Ledyard Weld, first secretary of Colorado Territory.

Logan County (1887) was named for Gen. John A. Logan (1826–86) who died shortly before the organization of the county.

Boulder County (1861) was named after Boulder City and Boulder Creek, which derived their name from the abundance of boulders in the locality.

Engineering Structures

Arkins Dam and Reservoir, located on Buckhorn Creek, a tributary of the Big

Granby dam site, looking up the Colorado River

Shadow Mountain Government camp. Employees' cottages

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[1] This is Part III in the series of articles on this subject, Parts I and II having appeared in the March and April issues. Part III includes the Colorado-Big Thompson, Buffalo Rapids, and Kendrick projects.

Thompson River, was apparently named for some early settler.

Big Thompson Feeder Canal, so named from the Big Thompson River, will extend from the draw one-half mile below Carter Lake Dam and will run into Cottonwood Creek, a tributary of the Big Thompson. The name "Thompson" came from that of an early explorer, a Lieutenant Thompson.

Carter Lake Dam, Reservoir, and Supply Canal.—It is assumed that these structures were named from a settler many years ago. The dam will be constructed about 1 mile north and 7 miles west of Berthoud, Colo. The proposed reservoir is a natural basin which will be supplied by the canal.

Continental Divide Tunnel.—This, the major feature of the Colorado-Big Thompson project, pierces the Continental Divide more than 4,000 feet below the crest, and for this reason the long tunnel was appropriately named. Unlike many Reclamation projects, the Colorado-Big Thompson is divided by the Continental Divide into two distinct parts; those features necessary to the storing of surplus and the diversion of waters located on the western slope, and those features which include canals and reservoirs necessary to the regulation and delivery of water on the eastern slope.

The East Portal Highway is so-named because the road connects to the main highway near Estes Park and extends to the east portal of the Continental Divide Tunnel.

Granby Dam, Reservoir, Pumping Plant, and Substation.—Granby Hillyer, from whom these features obtained their name, was a lawyer who settled on the project and helped to establish the town of Granby. The dam will be constructed about 4 miles northeast of Granby and the pumping plant about one-half mile above the junction of the South Fork with the Colorado. The substation furnishes power to the town of Granby.

Greeley-Fort Morgan Transmission Line and Greeley, West Portal, Loveland, and Estes Park Substations.—The proper names of these features came mostly from individuals who contributed their part in the history of the project. These were Horace Greeley, editor of the "Tribune" and active supporter of the project; Col. C. A. Morgan, well known Union officer who died January 20, 1866; W. A. H. Loveland, under whose supervision the railroad was built; and Joe Estes, who constructed the first cabin in the locality in 1859.

Green Mountain Dam and Power Plant; Green Mountain Government Camp and Green Mountain Substation; Green Mountain-Grand Lake Transmission Line.—So named because of their proximity to Green Mountain, which had derived its name from its heavily timbered surface. The dam is located in the canyon between Green Mountain and Little Green Mountain; the camp and substation were so called in order to identify them with the dam; and the transmission line is so named because it extends from the dam to the village of Grand Lake.

Horsetooth Dam and Reservoir, Soldier Canyon, Dixon Canyon, and Spring Canyon; Horsetooth Supply Canal.—The reservoir apparently was named from Horsetooth Mountain located almost due west of Fort Collins. The mountain was named by an unknown man, probably an early trapper, who, in approaching the mountains in that section noticed by the exercise of considerable imagination that the peak resembled the tooth of a horse. Frontier gossip and repetition made the name stick. The proposed reservoir will occupy a valley 6 miles long and one-fourth to three-fourths of a mile wide west of Fort Collins. The dam will cross the valley at the north end and on a low saddle separating the valley from drainage to the north into the Poudre River.

On the reservoir there are three natural outlets to the east through the Dakota hogback namely, Soldier, Dixon, and Spring Canyons, which are sites of three proposed dams of the same names in addition to the larger dam, Horsetooth. Apparently the name Dixon was in recognition of a man of the same name. Spring Canyon derives its name from a bountiful spring in the canyon. No record of the name of Soldier Canyon has been found.

Because the supply canal empties into Horsetooth Reservoir it was named Horsetooth Supply Canal. The canal starts at the end of a siphon across the Big Thompson River from Power Conduit No. 4, then north to the Horsetooth Reservoir.

Hot Sulphur Springs Substation.—This substation derives its name from the town of Hot Sulphur Springs, the town having been named for the natural springs which provide healthful baths to many not only from the surrounding territory, but in the entire country.

Loveland-Estes Park and East Portal Transmission Line.—The derivation of Loveland and Estes has been given under "Greeley-Fort Morgan Transmission Line and Greeley, West Portal, Loveland, and Estes Park Substations."

Meadow Creek-Strawberry Creek Diversions.—Meadow Creek derives its name from the meadow through which it passes, and Strawberry Creek was so named from the patches of wild strawberries that line its bank.

North Fork Diversion Dam.—This dam is so named from its proposed location, across the North Fork of the Colorado about one-half mile below its junction with the Grand Lake outlet. The purpose of the dam is to divert water of the North Fork into Grand Lake and thence to the channel extending from it to the West Portal of the Continental Divide Tunnel.

North Poudre Feeder Canal, North Poudre Pumping Plant, Poudre Feeder Canal, Poudre Valley Feeder Canal.—Poudre is the French word for "powder." Feeder and pumping are self-explanatory.

Power canals are numbered to correspond with the power plants to which they supply water.

Power plants are numbered according to their location, No. 1 being closest to Estes Park, No. 2 next below No. 1 downstream, and so on to Power Plant No. 4.

St. Vrain Feeder Canal.—The name St. Vrain tells a story of early trapping days and came from Ceran St. Vrain, a fur trader who was associated with the Bent Brothers in their trading enterprises. The St. Vrain River was the first to bear the name, and from it the feeder canal, which will extend from the small outlet of Carter Lake to the river, obtains its name.

Shadow Mountain Government Camp, Shadow Mountain Lake, and Shadow Mountain Substation.—Shadow Mountain rises abruptly from the south shore of Grand Lake and the shadow reflection visible in the lake is responsible for its name. The lake is formed by water backed up by the North Fork Diversion Dam. The camp in turn is named for the lake, and because the substation furnishes power to the new Shadow Mountain Government Camp, it has been appropriately named Shadow Mountain Substation.

West Portal Government Camp, West Portal Highway, and West Portal Substation.—These features are located west of the Continental Divide, hence the designation "West Portal."

Willow Creek Supply Canal.—Willow Creek is so-named because of the willow trees crowding along the banks of the stream into Granby Reservoir.

Mountains and Peaks

From gentle slopes, the Rocky Mountains rise to heights of more than 14,000 feet above sea level, forming the crest of the North American continent and separating the watersheds of the Pacific Ocean and the Gulf of Mexico. The crest of this high range of mountains (the most elevated portions in the United States are in Colorado) has been appropriately named the Continental Divide. It runs in a general north-south direction, and many small streams have their source in this high mountain range, which in turn are the headwaters of large rivers eventually emptying into the sea and the gulf.

The history of the naming of the peaks in this region is somewhat complicated, many of them having received two names and only in recent years having been definitely and authoritatively designated with certain appellations. Maj. Stephen Long, commanding an expedition of explorers 119 years ago, sent into the West by President Madison, first sighted the peak which later was to bear his name. Dr. Edwin James, famous botanist, who was a member of this expedition, ascended the peak and Major Long named it after him. Later the peak, which is one of the highest and longest known of the immortal beauties of Colorado, was renamed Longs Peak in honor of Major Long. It was Major Long and his party who also were the first white men to tread the region which now comprises the Rocky Mountain National Park. A few years later (in 1843) Rufus B. Sage, another explorer, visited the area. Since those days, this mountain territory has become a shrine of summer pleasure seekers. The United States Geological Survey lists 49 peaks that tower more than 14,000 feet above sea level, and 1,064 that have an altitude of more than 10,000 feet. It is estimated that there are as many unnamed peaks in the State reaching to a height of 14,000 feet as those that have been officially named.

Rivers

Because the purpose of the project is to divert waters from the headwaters of the Colorado River on the western slope of the Continental Divide into the Big Thompson River, which has its source on the eastern slope of the Divide, the name was changed from "Grand Lake-Big Thompson Transmountain Diversion Project" to "Colorado-Big Thompson Project" on July 18, 1936 The name "Colorado" is the Spanish for "ruddy" or "blood red," or in the secondary sense "colored." The name is also borne by two rivers and by a county in Texas. The Colorado River, prior to its designation as such by the National Geographic Board about 20 years ago, was known as the Grand. However, this stream bed had already gone through several changes in name. As late as 1876 Escamoba named it San Raphael and previous to that it was known as the Bunkara, so-called by the fur traders who derived the name from the Ute Indian designation for the river which was Nah-un-ka-rea. On the eastern slope the Big Thompson was originally called Thompson Fork of the Platte River. The stream was named for a certain Lieutenant Thompson who was a member of the party Fremont led over the area. Lieutenant Thompson was designated as "A man of more than ordinary merit."

The greater part of the natural basin described as northeastern Colorado or as the Northern Colorado Water Conservancy District is drained by the South Platte and its tributaries. Platte is a French name from plate, meaning "dull" or "shallow," a term singularly applicable to this stream. The trunk stream is formed by the union of several creeks that drain the mountains surrounding South Park. It breaks through the mountain barriers in Platte Canyon and flows northward to Denver. The course is then changed northeast to Fort Morgan, thence north and east to the Nebraska border.

After the trunk stream reaches the plains just north of Denver, numerous tributaries rising in the mountains flow into the river from the West. These include the Saint Vrain receiving the waters of Boulder Canyon, the Big Thompson, and the Cache La Poudre, the latter two rising in the Rocky Mountain Range in Larimer County. These streams, especially the Cache La Poudre, are of great importance as sources of water supply for extensive irrigated districts. Cache La Poudre River has a French name signifying "powder hiding place."

Towns

Some of the principal towns in the area of the project are named for the early settlers. They are as follows:

Fort Collins.—During the Indian Wars of the 1860's a military post called Fort Collins was established at the present site of the town. Col. W. O. Collins, of the 11th Ohio Regiment, located the post which took his name. When the fort was abandoned and the reservation was opened to settlement in 1872, the lands were taken up by a town company organized by Gen. Robert A. Cameron. The city of Fort Collins was founded by the company on the abandoned reservation, and was incorporated in 1883.

Fort Lupton.—The fur trading post, Fort Lupton, was founded in 1836 by Lancaster P. Lupton. He forsook his post in the 1840's and in 1849 moved with his Indian wife and family to California. Soon after the gold rush to Colorado in 1859, farmers took up ranches in the vicinity. The old adobe fort became a stage station in the mail and express route from the Missouri River to Denver. It also served as a place of refuge during the Indian uprising of 1864. The town site was surveyed by L. P. Drake in November 1881, and plat filed in June 1882 by W. G. Wimbourne.

Fort Morgan.—The first military post at the site was named Camp Tyler; later it was changed to Camp Wardwell; and on June 23, 1866, it was named Fort Morgan in honor of Col. C. A. Morgan, prominent Union officer who died January 20, 1866. It was located at the junction of the Denver cutoff and Platte River roads. The old sod fort was built in the summer of 1865 by a detachment of "galvanized Yanks." The post was abandoned in 1868. Ranches were taken up in the vicinity in the 1870's. The present town was founded in 1884 and was incorporated in 1887.

Greeley.—The town was founded by the Union Colony in 1870. Nathan C. Meeker, agricultural editor of the New York Tribune, was the chief organizer of the enterprise. The town, named for Horace Greeley, was a semicooperative undertaking and was the most successful colony founded in Colorado. It was incorporated by order of the county commissioners in May 1871.

Julesburg.—The original stage station of Julesburg was established in 1859 at Jules Heni's ranch on the south side of the Platte River, 1 mile east of the mouth of Lodgepole Creek. Julesburg has since made three migrations. The second Julesburg was established 4 miles east of Fort Sedgewick, just outside of the military reservation. The third was on the north side of the Platte and was for a time the terminus of the Union Pacific Railroad in 1867. Present Julesburg, farther east, first known as Denver Junction, was laid off by the Union Pacific when it built its line to Denver. The plat was filed in July 1884. The town was incorporated as Denver Junction in November 1885, and as Julesburg in 1886.

Longmont.—The town was founded by the Chicago, Colorado Colony, Robert Collyer, president. The company was organized at Chicago on February 22, 1870. Seth Terry, Andrew Kelley, and W. M. Byers selected the site. The company purchased 30,000 acres of land. The old town of Burlington, founded some years previously, was merged with Longmont. Settlement began under colony auspices in 1871, and the town was incorporated January 7, 1873. The name is cumulative of the name of Major Long (for whom Long's Peak is named) and the French *mont*, meaning mountain.

Loveland.—In 1877 the Colorado Central Railroad was built across the Big Thompson Valley, and the town of Loveland, formerly called St. Louis, was established. It was named for Hon. W. A. H. Loveland of Golden. David Barnes owned the land on which Loveland stands. He platted the town and has been called the Father of Loveland. The Barnes ditch supplied the first water for the community. The town was incorporated in 1881.

Kendrick Project, Wyoming

Kendrick project.—Formerly known as the Casper-Alcova project, with the enactment of the Interior Department appropriation bill for the fiscal year 1938, approved August 9, 1937, Kendrick project became the official designation in honor of the late Senator John B. Kendrick of Wyoming, in commemoration of his life and work for the State. Senator Kendrick was a staunch proponent of the project, and it was through his untiring efforts that the project became a reality when President Roosevelt approved its construction on August 30, 1935.

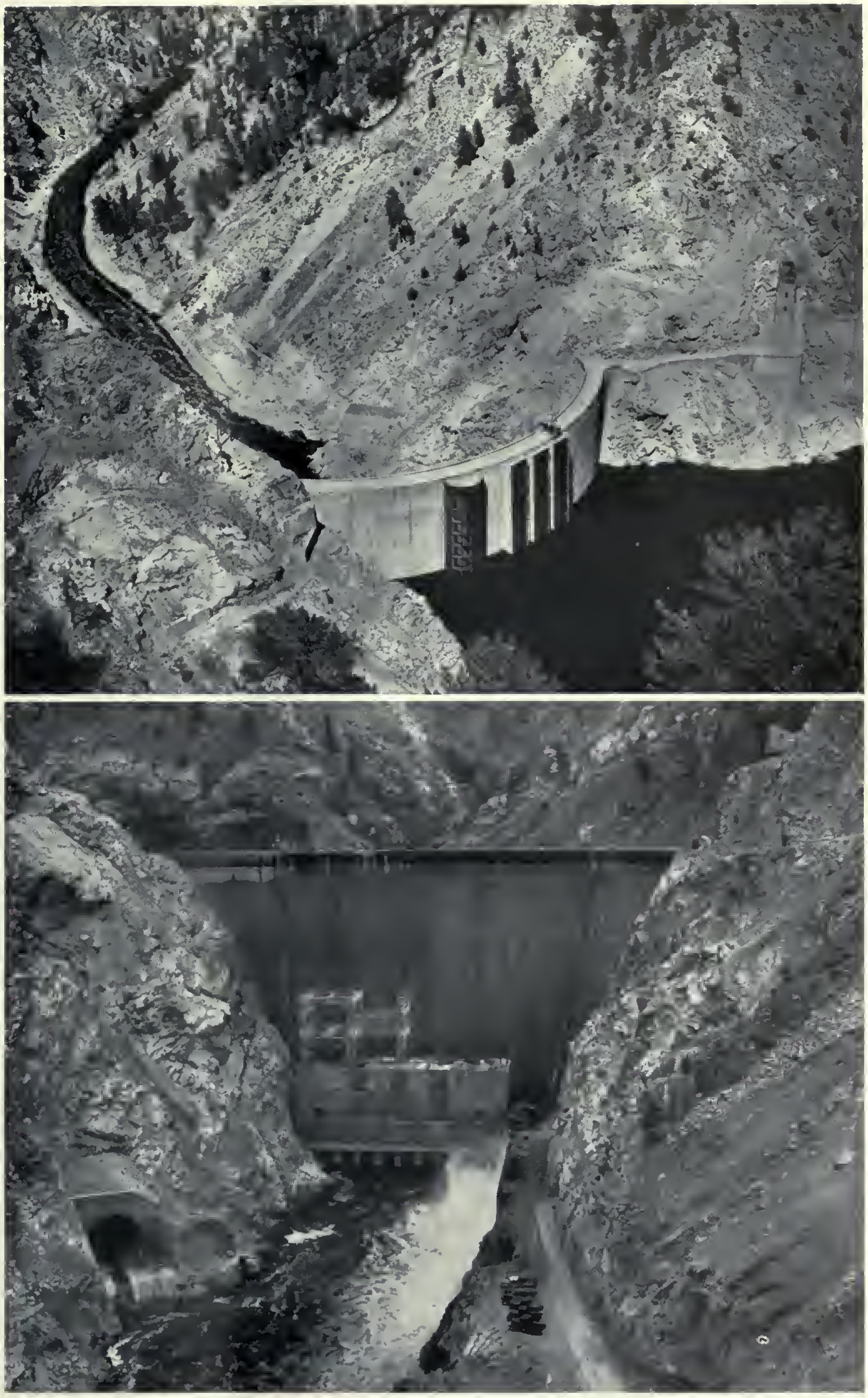
Alcova Dam.—This dam was named after the little town of Alcova, immediately adjacent to the dam site. Although no authentic information regarding the origin of the name "Alcova" has been obtained, it is assumed that it derived its name from the appearance of an alcove just above the present dam site, which Capt. John Fremont, an early explorer of the West, originally called the Hot Springs Gate. In 1890 an eastern syndicate had bright prospects of developing the hot mineral springs in the alcove and making the town a famous health resort to be the Arkansas of the West. However, the venture did not materialize. The syndicate was known as the Alcova Hot Springs Co., and it is possible the syndicate had something to do with the naming of the Alcova Canyon and the town of Alcova.

Seminoe Dam.—So named after the Seminoe Mountains. The following explanation of the derivation of the name "Seminoe" is quoted from the History of Natrona County by A. J. Mokler, an early pioneer who is still living in Casper, Wyo.

"Among the members of John C. Fremont's expeditions to the Rocky Mountains in 1842–43–45, was a voyageur Basil Lajeunessee, a man of sterling worth, who was named 'Seminoe' or 'Cimineau' by the Snake Indians with whom he lived for many years and into whose tribe he married. He was one of the men who ascended Fremont Peak on August 15, 1842. Early in the expedition, when drought and grasshoppers had swept the country so that scarce a blade of grass was to be seen and there was not a buffalo, a deer, or antelope for food in the whole region, the Ogallallah Indians warned Fremont not to proceed lest he should starve, and Fremont put it to his men whether they should turn back, but not a man flinched from the undertaking. 'We'll eat the mules,' said Basil Lajeunesse. They pushed forward, and although they suffered hardships and privations, they did not eat the mules on this expedition, but they lived on half rations. On the second expedition in 1843, however, they did eat their mules, as was the fortune of many western travelers in that year and other years to follow. The name 'Cimineau' endures in Wyoming in the Seminoe Mountains. The old settlers who remembered Lajeunesse said that the mountains were called Seminoe to perpetuate the name of one of the bravest and truest pioneers of Wyoming. By some of the modern map makers the name of this range of mountains has been corrupted into 'Seminole', but there is no 'l' used in the spelling, and the correct pronunciation is 'Seminoe', or 'Cimineau'."

The Cheyenne Daily Leader, March 22, 1882, gives the following statement from Rawlins Journal:

"Seminoe was killed on Clark's Fork of the Yellowstone by Araphoe Indians in the spring of 1865. He and a Frenchman known as Big Joe went up there to get some cattle and wagons they had purchased from emigrants who had abandoned them. They had got the outfit and started back, making one day's drive. Shortly after camping for the night a party of Araphoes came into camp, ate supper, and slept there, taking breakfast with them in the morning. While Seminoe and Joe were out yoking up their cattle they brutally shot them down; at least this was the story the Indians told. Jules, a young son of Seminoe's, when he learned of the brutal murder of his father, made a vow to be revenged, and during the years 1865–66 did good service, boy or almost child that he was. We remember very distinctly seeing Jules away out in advance of the troops at the fight of Platte Bridge (now Fort Casper) in July 1865. He was then seated behind a sage brush with his father's old muzzle-loading Mississippi rifle, at the crack of which an Indian was sure to 'bite the dust.' The gun was so heavy that in order to fire it he had to rest it across the sage. The writer with 10 men was ordered forward to bring him in. The little fellow cried when told he must come back. Jules was in several skirmishes with the Eleventh Ohio Cavalry that summer, and was rash al-



Seminoe Dam, Kendrick project, Wyoming

Alcova Diversion Dam, Kendrick project, Wyoming

most to insanity, not apparently having any knowledge of fear.

"Seminoe at one time had a camp up on Bear (now Dewees) Creek, near where the mining camp is located, and the place was known as Seminoe's Camp."

Buffalo Rapids Project, Montana

Statements regarding place names on this project were obtained through several sources, including the local library, the Historical Society of Montana, and Clyde McLemore; Mr. McLemore having made an intensive study of the region.

Buffalo Rapids project was so named by Capt. William Clark, of the Lewis and Clark Expedition, who descended the Yellowstone with a few members of the party, including Sacagawea and her French-Canadian husband, Touissant Charboneau, and made an entry in his journal for August 30, 1806, to the effect that they had encountered and passed a succession of shoals for 6 miles, the last of which was completely across the river and appeared to have a descent of about 3 feet. He stated that this was by far the worst place he had seen on the river from the Rocky Mountains, a distance of 694 miles by water. He further related that a large canoe would with safety pass through the worst of those shoals, which he called the Buffalow Sholes because of the presence of a buffalo in them. Clark's Buffalow Sholes is the Buffalo Rapids of today.

Bad Route Creek.—In October 1876 Col. Nelson A. Miles had a running battle with the Sioux, led by Sitting Bull along the stream, and his official report refers to it as Bad Route Creek, the obvious suggestion being that it is a translation of an Indian name for the stream.

Crackerbox Creek.—This creek is named after a character called Crackerbox Dan, who was well known along the Yellowstone about 1877. According to legend, during the early days when Indians were on the warpath and Glendive was an army fort, Dan was a trapper having a shack on the creek. The Indians drove him out and he started for the fort, but fearing he would be unable to outrace them, he sought refuge on top of a knoll about 18 miles southwest of the fort. Here he dug a trench for protection, using a wooden box, formerly containing hardtack, which he found at an abandoned army camp. Lying in the trench he held off the Indians until passing soldiers heard the shots and rescued him. In relating his experience he referred to his digging tool as an old crackerbox, and after that he was known as Crackerbox Dan.

Glendive.—This town received its name for a nearby creek which was named in 1856 by Sir George Gore, a wealthy Irish nobleman who, after an extended big game hunting trip in northern Wyoming, the Black Hills, and southeastern Montana, returned to St. Louis via the Yellowstone and Missouri Rivers. On this trip he camped for a short time near the mouth of the creek and was so impressed by the beauty of the place that he called it Glendale or something similar, after one of his favorite spots in Ireland. By some mistake the name was changed to Glendive, and this name appears on early maps made before the town was established.

Hatchet Creek.—No possible information is available concerning the origin of this name, but it is suggested that it comes from a cattle company which had extensive holdings in the region in early days, and whose brand was known as the Hatchet brand.

Upper and Lower Seven Mile Creeks probably obtained their names because of their location 7 miles up and down the Yellowstone from a peak which was used as a lookout station and at present bears the name "Custer's Lookout." Whether Custer himself ever used the peak as a lookout is unknown.

Giant Transformers Ordered for Grand Coulee Dam Power Plant

THREE 36,000-kilovolt-ampere, 60-cycle, single-phase, oil-immersed transformers for the L3 unit of the Grand Coulee Dam power plant, Columbia Basin project, Washington, will be purchased from the General Electric Co., of Schenectady, N. Y., at its low bid price of $247,150, comprising the initial installation, except for two station service units, in the left powerhouse. Turbines and generators for these three units have a combined capacity of 324,000 kilowatts already on order.

The power plant at Grand Coulee will consist of two separate but similar powerhouses, one on each side of the dam, each to contain, when completed, nine of the 108,000 kilovolt-ampere generators with a total ultimate capacity of 1,944,000 kilowatts. The existing contract for the construction of Grand Coulee Dam to its full height provides for the completion of the left powerhouse, but includes only the foundation of the right powerhouse.

The transformers, without oil, will be shipped within 200 calendar days after date of receipt by the contractor of notice of award of contract, and shipment of the oil for the transformers is desired within 10 days after notice to ship the oil.

Although some power from the service station units may be available this fall, it is not expected that the plant will go into operation until about the end of 1942.

Building Activities, Shoshone Project

WORK is progressing satisfactorily on the club house that is being constructed by the local Townsend Club. The building when completed would be a credit to any town.

A new brick building large enough to accommodate two business establishments is also under construction.

NOTES FOR CONTRACTORS

Specification No.	Project	Bids opened	Work or material	Low bidder		Bid	Terms	Contract awarded
				Name	Address			
1329-D	Parker Dam Power, Calif.-Ariz.	Feb. 28	One 200-ton, double-trolley, motor-operated, overhead traveling crane for Parker power plant.	Cyclops Iron Works	San Francisco, Calif.	$52,580.00	Discount ½ percent	Apr. 2
1331-D	Central Valley, Calif.	Mar. 25	Construction of 69-kilovolt transmission line and 2,300-volt distribution lines for Contra Costa pumping plants Nos. 1, 2, 3, and 4.	Moore Electric Co.	Los Angeles, Calif.	5,406.00		Mar. 30
1337-D	Colorado-Big Thompson, Colo.	Mar. 18	Furnishing and installing 2-pipe steam-heating system for headquarters garage.	(1)				
1338-D	Columbia Basin, Wash.	Mar. 22	Structural-steel framing for the hatchery building at the Entiat station.	The Midwest Steel & Iron Works Co.	Denver, Colo.	2,412.00	F. o. b. Entiat; discount ½ percent. Shipping point Pueblo, Colo.	Mar. 28
1339-D	Central Valley, Calif.	Mar. 25	Structural-steel work for testing (at Boulder Dam) the 26-inch tube valve for Shasta Dam.	Pittsburg-Des Moines Steel Co.	Des Moines, Iowa	1,067.00	Discount 1 percent	Mar. 29
34	Parker Dam Power, Calif.-Ariz.	Mar. 20	Unloading and hauling materials	A. L. Snuffer	Phoenix, Ariz.	39,900.00		Apr. 2
892	Yakima-Roza, Wash.	Mar. 1	Earthwork, concrete wasteway section and structures for Wasteway No. 4 at station 2386+67.98, Yakima Ridge Canal.	H. J. Adler Construction Co.	Yakima, Wash.	144,105.00		Apr. 1
894	Boulder Canyon, Ariz.-Nev.	Mar. 7	Construction of high school building at Boulder City.	White and Alter	Elko, Nev.	[2] 49,124.20 [3] 1,320.00		Apr. 2 Do.
896	Columbia Basin, Wash.	Mar. 14	Three 36,000-kilovolt amperes, 60-cycle, single-phase, oil-immersed, water-cooled, 13,600- to 132,800/230,000 Y-volt transformers for unit L-3, Grand Coulee power plant.	General Electric Co.	Schenectady, N. Y.	247,150.00	F. o. b. Odair. Shipping points Pittsfield, Mass. and Richmond, Calif.	Do.
1342-D	Central Valley, Calif.	Mar. 27	6 welded plate-steel oil-storage tanks for the Shasta power plant.	California Steel Products Co.	San Francisco, Calif.	3,474.00	Discount 1 percent	Apr. 4
1340-D	Colorado-Big Thompson, Colo.	do	Disconnecting switch, lightning arrester, expulsion fuses, transformers, switching and metering unit (Troublesome substation).	Johnson Manufacturing Co. General Electric Co. Kelman Electric & Manufacturing Co.	Atlanta, Ga. Schenectady, N. Y. Los Angeles, Calif.	[4] 512.00 [6] 282.00 [11] 2,470.40	F. o. b. Kremmling, Colo. do do	Apr. 5 Apr. 8 Apr. 9
1341-D	Central Valley, Calif.	Apr. 1	Absorptive form lining for Friant Dam (150,000 square feet).	The Celotex Corporation	Chicago, Ill.	5,280.00	F. o. b. Friant	Apr. 22
1344-D	Colorado-Big Thompson, Colo.	Mar. 28	Modified portland cement in cloth sacks (18,000 barrels).	Monolith Portland Midwest Co.	Denver, Colo.	37,800.00	F. o. b. Laramie; discount and sack allowance, $0.50 per barrel.	Apr. 17
1345-D	Columbia Basin, Wash.	Apr. 10	Structural-steel framing for hatchery building at Winthrop station.	Willamette Iron & Steel Corporation.	Portland, Oreg.	3.190.00		Do.
1346-D	Parker Dam Power, Calif.-Ariz.	Apr. 11	Five welded plate-steel, oil-storage tanks for Parker power plant.	Lacy Manufacturing Co.	Los Angeles, Calif.	2,992.00		Apr. 18
1347-D	Boulder Canyon, Ariz.-Nev.	Apr. 12	Manual telephone switchboard equipment for Boulder power plant.	American Automatic Electric Sales Co.	Chicago, Ill.	2,619.58		Do.
1350-D	Deschutes, Oreg.	Apr. 15	2 discharge guides for 90-inch tube valves for outlet works at Wickiup Dam.	The Steel Tank & Pipe Co. of Oregon.	Portland, Oreg.	3,400.00		Apr. 20
2461-A	Carlsbad, N. Mex.	Mar. 11	Standard portland cement in cloth sacks (10,000 barrels).	Universal Atlas Cement Co.	Chicago, Ill.	18,112.64	F. o. b. Independent, Kans.; discount and sack allowance, $0.50 per barrel.	Apr. 5
33444-A	Central Valley, Calif.	Mar. 27	Steel reinforcement bars (5,250,000 pounds).	Columbia Steel Co.	San Francisco, Calif.	100,100.00	F. o. b. Coram, Calif.; discount ½ percent on $0.27 less than bid prices.	Apr. 17
16015-A	Buford-Trenton, N. Dak.	Apr. 8	Tractors and scrapers	Caterpillar Tractor Co. R. G. Letourneau, Inc.	Peoria, Ill. do	[2, 7] 29,147.00 [3, 9] 12,950.00	Discount $250. F. o. b. Buford and Williston, N. Dak.; discount 2 percent.	 Apr. 22
902	Colorado-Big Thompson, Colo.	do	Construction of Continental Divide Tunnel (8,000 feet).	S. S. Magoffin	Englewood, Colo.	471,123.00		Apr. 24
893	Columbia Basin, Wash.	Mar. 20	Control and switching equipment for station service units at Grand Coulee power plant.	Cutler-Hammer, Inc. Allis-Chalmers Manufacturing Co. Cutier-Hammer, Inc. do General Electric Supply Corporation.	Milwaukee, Wis. do do do Denver, Colo.	[2] 16,234.00 [3] 99,607.00 [7] 38,898.00 [8] 13,953.00 [10] 8,877.00	F. o. b. Odair, Wash. do do do Shipping point, Seattle, Wash.; discount 2 percent.	Do. Do. Do. Do. Apr. 4
897	do	Mar. 28	Cold storage and heating plants and heating systems for hatchery and for garage and warehouse at Leavenworth station.	MacDonald Construction Co.	St. Louis, Mo.	52,137.25		Do.
1333-D	Tucumcari, N. Mex.	Mar. 5	Furnishing and delivering 2,000 tons of sand and 3,000 tons of gravel.	Texas Sand & Gravel Co.	Amarillo, Tex.	[3] 9,531.00	F. o. b. Tucumcari	Apr. 15
16011-A	Buford-Trenton, N. Dak.	Mar. 29	Dragline excavators and buckets	Osgood Co.	Marion, Ohio	[3] 10,447.00		Apr. 25

[1] All bids rejected. [2] Schedule 1. [3] Schedule 2. [4] Item 1. [5] Item 2 [6] Item 3. [7] Schedule 3 [8] Schedule 6. [9] Schedule 4. [10] Schedule 5. [11] Item 5.

Land Drainage and Flood Protection

A BOOK on this subject, formerly published by the McGraw-Hill Co., is now published by the Stanford University Press, Stanford University, California. Its author is Prof. Bernard A. Etcheverry, member of the American Society of Civil Engineers, consulting engineer, and professor of irrigation and drainage, University of California.

This work deals with the surface drainage and underdrainage of agricultural lands affected by excessive water due to precipitation or irrigation, the protection of lands against flood or tide waters, and the methods of spreading assessments for the apportionment of the cost of the several classes of improvements to the areas benefited.

The first eight chapters deal mainly with the surface and underdrainage of lands in which the need for drainage results from excessive precipitation or lack of natural drainage.

Chapter IX is on the subject of drainage of waterlogged irrigated lands; Chapter X covers the protection of lands from flood waters and deals with the planning and design of levee systems; Chapter XI presents problems in the computation of flow in river channels; Chapter XII deals with the subject of tidal lands; and Chapter XIII, drainage and reclamation districts, purposes, aims, etc.—*M. A. S.*

Fresno Dam Completed

THE Bureau of Reclamation has completed another storage dam—Fresno Dam on the Milk River project in Montana. The new dam will create a reservoir which will provide a supplemental supply of water for irrigating Milk River project farms and also provide irrigation water for the Fort Belknap Indian Reservation. In addition, it will insure a domestic water supply for several nearby towns, create an adequate supply of fresh water for a migratory waterfowl refuge, and provide flood protection.

Construction work on the dam began March 29, 1937. A total of 1,693,170 cubic yards of compacted earth, rock riprap, and concrete went into the structure, which is 109 feet high and 1,855 feet long, and will create a reservoir capable of storing 127,230 acre-feet, or more than 40 billion gallons of water.

Completion of Fresno Dam has almost doubled water storage capacity on the Milk River project. The two other storage dams on the project—Sherburne Lakes and Nelson—have created reservoirs with a combined capacity of 134,600 acre-feet.

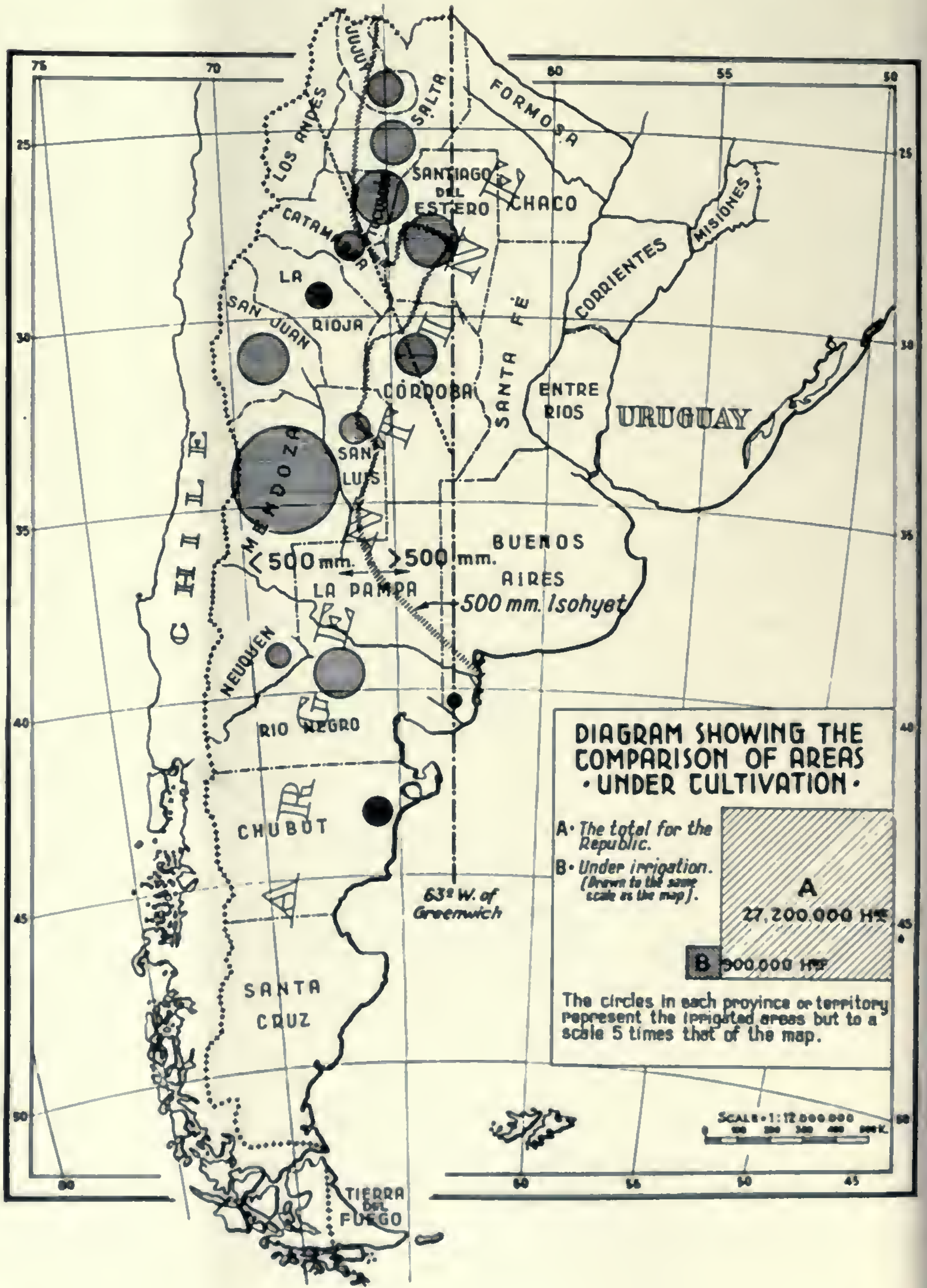
The Milk River project has an ultimate irrigable area of 147,061 acres, about 60,000 acres of which is now under irrigation and being cropped. The population of the project is about 13,400, including 11,700 townspeople. Chief crops grown on the project's irrigated farms are sugar beets and forage.

Irrigation in Argentina

OUR farthest southern good neighbor, the Argentine Republic, is developing irrigation—with problems which present a marked similarity to those of the United States.

Argentina has 67.2 million acres (27.2 million hectares) under cultivation, of which 2.2 million acres (0.9 million hectares) are under irrigation. Irrigation is resorted to west of 63 W. Meridian of Greenwich, which is the "West" of Argentina. In the tropical north—on the Salta, Jujuy, and Tucuman Provinces—sugarcane, citrus, cotton, and tobacco are raised; in the temperate center—San Juan, Mendoza, Córdoba, and Rio Negro Provinces—alfalfa, grapes, pears, apples, and vegetables; and in the colder south—Chubut—alfalfa, apples, and vegetables.

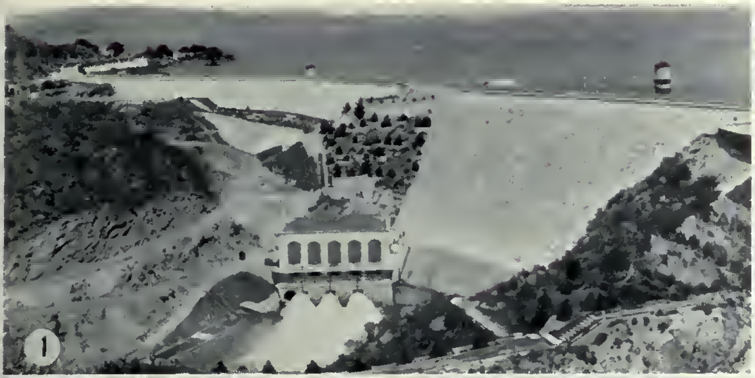
The Provinces or States are responsible for most of the irrigated area. The Federal Government has under direct control 270,000



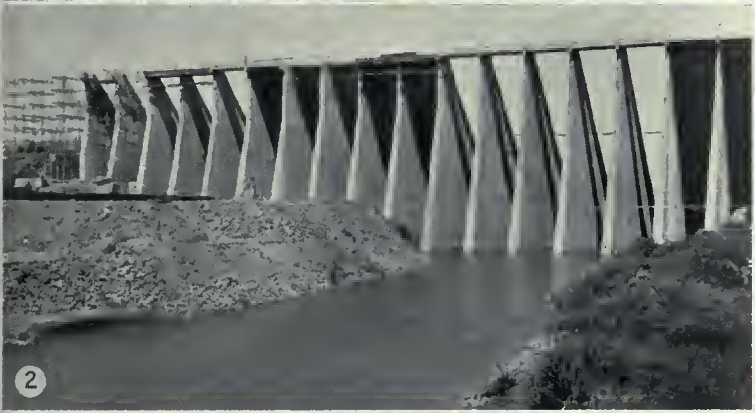
acres (110,000 hectares) in some provinces and national territories and almost all of the storage works.

All construction activities of the Argentine Federal Government are carried on through the Ministry of Public Works, in which the "Dirección General de Irrigación," Rodolfo E. Ballester, is in charge of the irrigation, flood control, and drainage problems.

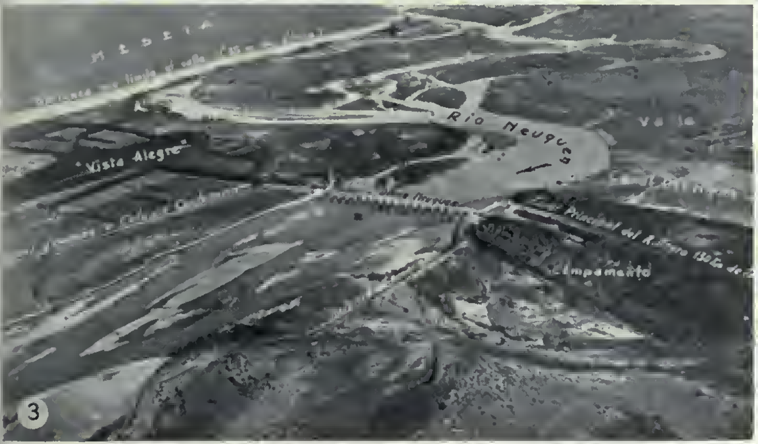
The Rio Tercero Dam was constructed by Engineer S. E. Fitz-Simon, who is now going



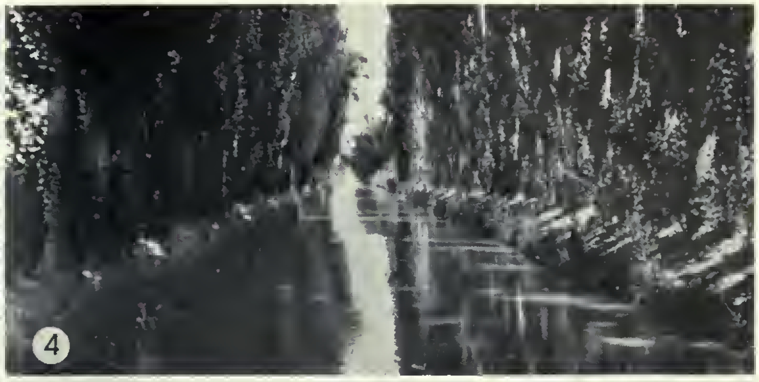
Río Tercero Dam. A rock fill structure 170 feet high, 450,000 acre-feet storage, for flood control, irrigation, and power. The power plant (15,000 horsepower) is in foreground



San Felipe Storage Dam. An Ambursen dam, 90 feet high, 100,000 acre-feet capacity, for regulation of Conlara River at San Luis province. Purpose: Improvement of 15,000 acres irrigated from the Conlara River

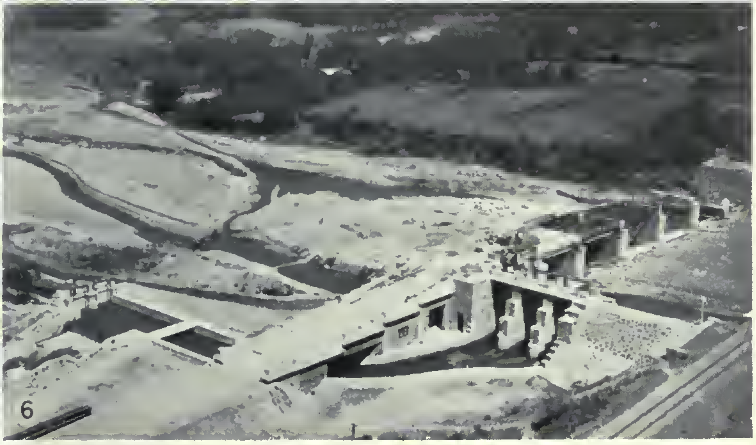


Neuquén Diversion Dam. A movable dam, 17 stoney sluices, 66 feet high, for diversion of 1,750 cubic feet per second, to the main canal of Río Negro project; 80 miles long, for irrigation of 130,000 acres. A spillway channel 1,310 feet wide permits the diversion of 70,000 cubic feet per second to a big lateral depression, for flood control



A lateral with poplar plantation along the banks. Shade of poplars prevents weed growth in the channel. When channels require cleaning for silting, plantation is made along only one of the banks

La Ciénaga Storage Dam, Jujuy. An earth-rolled fill dam 70 feet high, 17,000 acre-feet capacity. Water for the reservoir is diverted from Perico River at Tipal Diversion Dam. As solid discharge was too heavy, it was necessary to build a lateral storage dam instead of one across the river

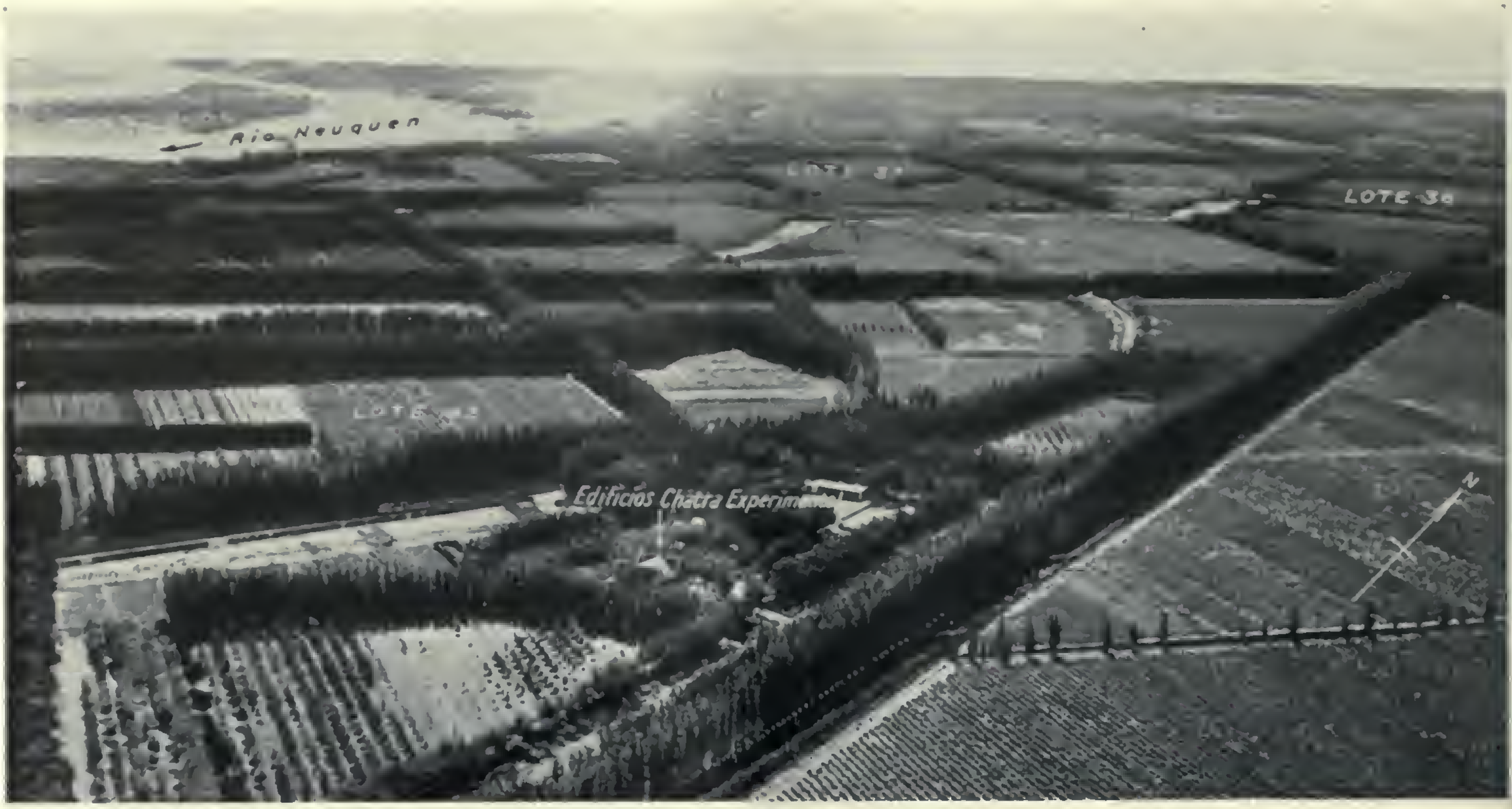


Río Toro Diversion Dam at Rosario de Lerma, Salta. Intake and desilting works at left, a highway bridge under construction over the dam. For irrigation of 12,600 acres of the Campo Quijano project

We are endebted for these pictures to Professor Ballester ahead with the construction of La Viña Dam (arch dam 330 feet high) across Los Sauces River.

Both Director General Ballester and Construction Engineer Fitz-Simon visited the United States, and reclamation territory in particular.

(*Editor's note:* The practice here depicted of planting canal banks with trees is not used generally in the United States because of the tremendous loss of water in their maintenance.)



Cultivated zone in the Río Negro System. A 130,000-acre unit showing growth of grapes, apples, and pears at "Cinco Saltos," Río Negro. In many sections of Argentina, poplars along the canals serve as windbreaks

Articles on Irrigation and Related Subjects

By W. I. SWANTON, Engineering Division

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Angell, Hon. Homer D.
America at the Cross Roads (Potentialities of Columbia Basin). Cong. Record, Feb. 14, 1940, v. 86, No. 30, pp. 2287–92.

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America's Biggest Ditch—Hell's Canyon, Snake River, by Richard L. Neuberger, in Coast, December 1939, Cong. Record Feb. 2, 1940, v. 86, No. 22, pp. 1578–1579.

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Making a water tunnel entrance 165 feet below lake surface, drawings. Engineering

News-Record, Mar. 14, 1940, v. 124, No. 11, p. 53 (371).

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Olander, H. C.
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(Continued on page 154)

Southwestern Project Barbecue

ON a spring evening early this year the Federal Union employees of the All-American Canal and Gila projects held a barbecue and informal dance on Prison Hill near Yuma, Ariz.

These views show two pigs in the container before receiving the 16-hour hot treatment, and Associate Engineer Kenneth Sawyer basting them with olive oil.

Yuma Auxiliary Citrus Shipments

DURING the month of March 86 carloads of packed grapefruit were shipped by rail from the Yuma Auxiliary project to the Pacific coast and midwestern markets, and the equivalent of 52.7 carloads of loose and packed grapefruit and 30.4 carloads of oranges were shipped by truck to the Pacific coast.

Boulder City to Have High School

CONTRACT has been awarded for the construction of a high school building at Boulder City, Nev., headquarters of the Boulder Canyon project and the Government's model town.

The building, which is to be located in block No. 15A near the present grade school building, will be 96 by 102 feet in size, and will include a gymnasium, a manual-arts room, a science laboratory, a domestic science room, a stage, two classrooms, toilets, shower rooms, and dressing rooms. The walls will be of concrete and the sloping portions of the roof of mission tile. The building will be equipped with a complete electrical system and will be heated by a two-pipe steam heating system connected to the boiler in the present school building.

The new structure will make it possible for students to attend high school in Boulder City. At present the high-school students, numbering almost 100, are transported to the high school at Las Vegas by the district, of which the Boulder City area is a part. The town has always had excellent grade schools and, with the addition of the high school, educational facilities will be provided for approximately 400 school pupils. With a population of about 6,000 during the peak construction days at the dam, the town now has about 3,500 permanent residents.

The building is expected to be ready for use this year. The contractor is required to complete all the work within 150 days after receiving notice to begin construction.

Articles on Irrigation

(Continued from page 153)

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YOUNG, WALKER R.

Shasta Dam would have reduced flood by half, U. S. Engineer estimates. Southwest Builder and Contractor, Mar. 22, 1940, v. 95, No. 12, pp. 5–6.

Fish Planted in Owyhee Waters

OF THE 100,000 Cut Throat trout allocated to the Owyhee Reservoir, the first consignment of 24,000 have been planted by Leslie Zumwalt, of the State Game Commission, and the remainder are scheduled for early arrival from the Commission's hatchery near Maupin, Oreg. Rainbow trout will be planted in the Owyhee River and in the lake some time later.

Cut Throat and Rainbow trout are assigned to the Beulah Reservoir, and the Burnt River Reservoir is also to receive a large stock of Rainbow.

Lake and stream surveys in the section are being made by Mr. Zumwalt to determine their capacity for fish planting, and Mr. Zumwalt, accompanied by Norman Minnick, of the game-protection division of the State police, has started to familiarize himself with Malheur County reservoirs, which work will be continued for some years until the waters of the entire State are charted.

Klamath Potatoes

THERE was a marked improvement in the price received for potatoes on the Klamath project during March, at the close of which U. S. No. 1 brights were selling at $1.10 to $1.30 per hundredweight. About 1,280 cars were shipped from the project during the month, bringing shipments for the season to about 6,360 cars.

N. R. A. to Convene in September

O. S. WARDEN, president, has announced that the ninth annual meeting of the National Reclamation Association will be held in Great Falls, Mont., September 24–26, 1940. The convention dates have been set earlier than usual this year in order to avoid conflict with western farmers' harvesting schedules and the national elections.

Associated Engineers of the University of Nevada Meet

THE Associated Engineers of the University of Nevada held their 1940 annual banquet on March 8, at which Irving C. Harris, director of power of the Boulder Canyon project, represented the Bureau and addressed the group on the subject Some Sections of the Historical Background of Boulder Dam.

Interior Department Begins Summer Schedule

DEPARTMENTAL Order No. 1460, dated April 8, 1940, directs that, with the exception of the Bureau of Fisheries, Bureau of Biological Survey, Bituminous Coal Division, St. Elizabeths Hospital, and Freedman's Hospital, effective April 15, the Department of the Interior will commence the summer schedule of office hours from 8 a. m. to 3:30 p. m., except on Saturdays, when the hours will be from 8 a. m. to 12 noon.

Golden Gate International Exposition Reopened May 25

VISITORS to the exposition during the season 1940 will find exhibits of the Central Valley project in California housed in two buildings. In the Shasta-Cascade Building there is installed a 6-foot table model of Shasta Dam, the structure on the Sacramento River, and in the Federal Building are a 14½-foot diorama of the Central Valley project and a 6-foot table model of Friant Dam, the structure on the San Joaquin River.

Friends of the Land Formed

A NEW society called Friends of the Land was formed in Washington March 23. The aim of the society is to combat soil erosion, waste of rainfall, and the human waste and displacements which follow.

The organization is headed by Morris L. Cooke, who directed a Pennsylvania power survey for Governor Pinchot in 1923, served as first administrator of the Rural Electrification Administration, and was chairman of the Great Plains Committee.

Russell Lord, formerly of the Department of Agriculture and author of Men of Earth and Behold Our Land, is to edit a magazine to be published by the society. The magazine will serve as a medium for dissemination of conservation information.

Charles W. Collier, formerly of the Soil Conservation Service, Department of Agriculture, is the executive director.

The society will be nongovernmental and will seek subscriptions and backers among citizens in general "to support, increase, and, to a greater degree, unify all efforts for the conservation of soil, rain, and all the living products, especially Man."

Trustees of the organization include Rexford G. Tugwell, Paul Sears, Dr. Isaiah Bowman, Stuart Chase, Aldo Leopold, J. N. "Ding" Darling, and Dr. J. Russell Smith. Sponsors include Charles E. Beard, George T. Cochran, David Cushman Coyle, Albert Einstein, Mayor Fiorello H. LaGuardia, Archibald MacLeish, Miss Anne Mumford, Mrs. John Rogers, Jr., E. F. Scattergood, and Alfred Stieglitz. Prominent writers such as Richard Neuberger, Donald Culross Peattie, and Paul Sears are also sponsors, as is Raymond Gram Swing, radio news commentator.

In organizing the society, Mr. Cooke emphasized its nonprofit, nonpartisan, nonfactional character, and the need for the remedial conservation work to be advanced by it. "The land is all of one body," he said, addressing approximately 50 men and women gathered at Wardman Park Hotel to participate in forming the society. "In country and city, in trade or in science, in good times and in hard times, we all live on, or from, the soil. No matter which political party gains ascendancy as the years go by; whether the swing be from left to right or to farther left; whether we remain at peace or go to war again, this fact will remain: So long as we continue scrubbing off topsoil and fouling water sources, business and social conditions in this country will remain fundamentally unsound."

Gerald W. Johnson, author of The Wasted Land, commented on the organization, in the Baltimore Sun as follows:

"Whether or not the Friends of the Land are taking the best approach to their problem is debatable. They are not at the moment pressing any specific program of legislation. They are attacking, rather, the problem of public ignorance and inertia. This is most difficult, but it has the advantage of being a frontal attack. If the American people were actually informed and alert, then programs of legislation would be merely matters of detail."

The society will welcome subscriptions from all persons in furthering its work. Memberships at $5 each include a year's subscription to the monthly magazine The Land, first issue of which is planned for September.

First Contract on Continental Divide Tunnel Awarded

THE first contract for construction of the Continental Divide Tunnel of the Colorado-Big Thompson project, Colorado, covering an 8,000-foot section at the east end of the structure near Estes Park, was awarded on April 25 by Secretary of the Interior Harold L. Ickes.

Thirteen proposals were received, of which the successful bidder, S. S. Magoffin Co., Inc., of Englewood, Colo., submitted a bid in the amount of $471,123.

This contract requires the excavation of more than 38,000 cubic yards of material, the furnishing and installing of 900,000 pounds of permanent steel tunnel supports, and some other work. The contractor is allowed 430 days to complete the job after beginning work. In order to avoid delaying actual start of work, the tunnel portals were cleared in advance in order that drilling might be done promptly.

The tunnel is to be 9.75 feet in diameter inside the lining, 69,023 feet, or 13.1 miles in length, and will be lined throughout with concrete. The tunnel will extend from the east end of Grand Lake to Wind River, about 5 miles southwest of Estes Park. Water will be diverted through this tunnel from the upper Colorado River, on the Western Slope of the Continental Divide, to the headwaters of the Big Thompson River for use in supplementing irrigation supplies for 615,000 acres on the Eastern Slope in northeastern Colorado.

Recent Presidential Approvals

CONSTRUCTION under the Great Plains "relief" irrigation program of the Mirage Flats project in Nebraska and the Bismarck irrigation project in Burleigh County, N. Dak., has been approved by President Roosevelt and announced by Secretary of the Interior Harold L. Ickes.

The estimated cost of Mirage Flats is $2,560,000. The project, which for many years has been located in a dry area with frequent crop losses, will serve 12,000 acres on the north bank of the Niobrara River about 11 miles south of Hay Springs, Nebr. Old irrigation works built by local farmers were inadequate. Most of the land holdings are in 160-acre tracts or less.

The construction of Mirage Flats will be undertaken by the Bureau of Reclamation as soon as cooperating agencies in the Department of Agriculture have obtained the requisite control of excess lands in the project area, and have arranged for the repayment of reimbursable construction costs and for operation and maintenance of the project works.

The Bureau of Reclamation estimates that water users will be able to repay $985,000 over a period of 40 years in addition to carrying the costs of operation and maintenance. The remainder of the costs will be made up of expenditures by the Work Projects Administration largely for relief labor and expenditures in resettlement. The reimbursable expenditures will be made from a special appropriation of $5,000,000 made last year for construction, in addition to labor and materials to be supplied by the Work Projects Administration, of water conservation and utilization projects in the Great Plains and the arid and semiarid areas.

The plan is to construct a diversion dam on the Niobrara River at the upper end of the project, about 15 miles of main canal, and a system of laterals and farm ditches. An earth- and rock-filled dam will be built about 9 miles above the diversion dam to store 30,000 acre-feet of water. Construction also will include rough land leveling.

The Bismarck Project

The Bismarck project, North Dakota, will include 4,800 acres on the east side of the Missouri River directly south of Bismarck. The land lies in a strip 1½ to 2 miles wide between the Missouri River and the high bench to the east. Water for irrigation will be pumped from the Missouri River 20 feet and conveyed by 10 miles of main canal into the lateral and farm ditch system. Power for pumping will be obtained from the North Dakota Power & Light Co.

Some of the lands are in large tracts and it will be desirable to subdivide these. This work of subdivision will be undertaken by the Department of Agriculture which also will arrange for repayment of the reimbursable charges and for operation and maintenance. The project is estimated to cost $590,000, of which $250,000 will be reimbursable, this amount being made available from a special $5,000,000 appropriation made last year. The remainder will be nonreimbursable and will be expended by the Work Projects Administration largely for labor from the relief rolls. About 2 years will be required for completion of the project.

In accordance with the policy approved by the President for this type of project, the Bureau of Reclamation will not begin construction until suitable arrangements have been made for the establishment of farm units of a size which will permit the settling of the maximum number of families on the project.

Mirage Flats is the fourth and Bismarck the fifth of the projects to be approved for construction under the Great Plains water conservation and utilization program. Others include the Buford-Trenton project in North Dakota, the second unit of the Buffalo Rapids project in Montana, and the Rapid Valley project in South Dakota. It is anticipated that construction will require 3 or 4 years.

Departmental Order No. 1466

UNDER date of April 15, 1940, the Secretary of the Interior issued Departmental Order No. 1466 as follows:

"There is hereby created in the Office of the Secretary the position of 'Assistant to the Secretary in Charge of Land Utilization.'

"This Assistant to the Secretary shall be charged with the responsibility of coordinating and integrating the land-use activities of the several Bureaus of the Department and the supervision and maintenance of relationships with other governmental agencies, Federal, State, or local, as well as private, essential to the proper development of the conservation program of the Department. His function shall be planning and coordinating.

"The Assistant to the Secretary in Charge of Land Utilization will report to the Secretary on policy matters and will route his reports through the Bureaus affected, the Assistant Secretaries and the Under Secretary.

"For the time being the Office of the Assistant to the Secretary will be staffed by persons designated by the Secretary and selected from among the personnel of the various Bureaus of the Department. Although such persons will be on the basis of detail or loan, the period of such detail will be for not less than 6 months. During the term of such detail the staff members will be relieved of all duties in their own agencies."

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CUT ALONG THIS LINE

(Date).....................................

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Washington, D. C.

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May 1940.

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(Address)..

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Projects under construction or operated in whole or in part by the Bureau of Reclamation

Project	Office	Official in charge		Chief clerk	District counsel	
		Name	Title		Name	Address
All-American Canal	Yuma, Ariz	Leo J. Foster	Construction engineer	J. C. Thrailkill	R. J. Coffey	Los Angeles, Calif.
Belle Fourche	Newell, S. Dak	F. C. Youngblutt	Superintendent	J. P. Siebeneicher	W. J. Burke	Billings, Mont.
Boise	Boise, Idaho	R. J. Newell	Construction engineer	Robert B. Smith	B. E. Stoutemyer	Portland, Oreg.
Boulder Canyon [1]	Boulder City, Nev	Irving C. Harris	Director of power	Carl H. Baird	R. J. Coffey	Los Angeles, Calif.
Buffalo Rapids	Glendive, Mont	Paul A. Jones	Construction engineer	Edwin M. Bean	W. J. Burke	Billings, Mont.
Buford-Trenton	Williston, N. Dak	Perley R. Neeley	Resident engineer	Robert L. Newman	W. J. Burke	Billings, Mont.
Carlsbad	Carlsbad, N. Mex	L. E. Foster	Superintendent	E. W. Shepard	H. J. S. Devries	El Paso, Tex.
Central Valley	Sacramento, Calif	W. R. Young	Supervising engineer	E. R. Mills	R. J. Coffey	Los Angeles, Calif.
Shasta Dam	Redding, Calif	Ralph Lowry	Construction engineer		R. J. Coffey	Los Angeles, Calif.
Friant division	Friant, Calif	R. B. Williams	Construction engineer		R. J. Coffey	Los Angeles, Calif.
Delta division	Antioch, Calif	Oscar G. Boden	Construction engineer		R. J. Coffey	Los Angeles, Calif.
Colorado-Big Thompson	Estes Park, Colo	Porter J. Preston	Supervising engineer	C. M. Voyen	J. R. Alexander	Salt Lake City, Utah.
Colorado River	Austin, Tex	Ernest A. Moritz	Construction engineer	William F. Sha	H. J. S. Devries	El Paso, Tex.
Columbia Basin	Coulee Dam, Wash	F. A. Banks	Supervising engineer	C. B. Funk	B. E. Stoutemyer	Portland, Oreg.
Deschutes	Bend, Oreg	D. S. Stuver	Construction engineer	Noble O. Anderson	B. E. Stoutemyer	Portland, Oreg.
Gila	Yuma, Ariz	Leo J. Foster	Construction engineer	J. C. Thrailkill	R. J. Coffey	Los Angeles, Calif.
Grand Valley	Grand Junction, Colo	W. J. Chiesman	Superintendent	Emil T. Ficenec	J. R. Alexander	Salt Lake City, Utah.
Humboldt	Reno, Nev	Floyd M. Spencer	Construction engineer [2]		J. R. Alexander	Salt Lake City, Utah.
Kendrick	Casper, Wyo	Irvin J. Matthews	Construction engineer [3]	George W. Lyle	W. J. Burke	Billings, Mont.
Klamath	Klamath Falls, Oreg	B. E. Hayden	Superintendent	W. I. Tingley	B. E. Stoutemyer	Portland, Oreg.
Milk River	Malta, Mont	H. H. Johnson	Superintendent	E. E. Chabot	W. J. Burke	Billings, Mont.
Minidoka	Burley, Idaho	Stanley R. Marean	Superintendent	C. C. Patterson	B. E. Stoutemyer	Portland, Oreg.
Minidoka Power Plant	Burley, Idaho	Samuel A. McWilliams	Resident engineer		B. E. Stoutemyer	Portland, Oreg.
Mirage Flats	Hay Springs, Nebr	Denton J. Paul	Construction engineer		W. J. Burke	Billings, Mont.
Moon Lake	Provo, Utah	E. O. Larson	Construction engineer	Francis J. Farrell	J. R. Alexander	Salt Lake City, Utah.
North Platte	Guernsey, Wyo	C. F. Gleason	Superintendent of power	A. T. Stimpfig	W. J. Burke	Billings, Mont.
Ogden River	Provo, Utah	E. O. Larson	Construction engineer	Francis J. Farrell	J. R. Alexander	Salt Lake City, Utah.
Orland	Orland, Calif	D. L. Carmody	Superintendent	W. D. Funk	R. J. Coffey	Los Angeles, Calif.
Owyhee	Boise, Idaho	R. J. Newell	Construction engineer	Robert B. Smith	B. E. Stoutemyer	Portland, Oreg.
Parker Dam Power	Parker Dam, Calif	E. C. Koppen	Construction engineer	George B. Snow	R. J. Coffey	Los Angeles, Calif.
Pine River	Vallecito, Colo	Charles A. Burns	Construction engineer	Frank E. Cawn	J. R. Alexander	Salt Lake City, Utah.
Rapid Valley	Rapid City, S. D	Horace V. Hubbell	Construction engineer		W. J. Burke	Billings, Mont.
Provo River	Provo, Utah	E. O. Larson	Construction engineer	Francis J. Farrell	J. R. Alexander	Salt Lake City, Utah.
Rio Grande	El Paso, Tex	L. R. Fiock	Superintendent	H. H. Berryhill	H. J. S. Devries	El Paso, Tex.
Elephant Butte Power Plant	Elephant Butte, N. Mex	C. O. Dale	Acting Resident engineer	H. H. Berryhill	H. J. S. Devries	El Paso, Tex.
Riverton	Riverton, Wyo	H. D. Comstock	Superintendent	C. B. Wentzel	W. J. Burke	Billings, Mont.
Shoshone	Powell, Wyo	L. J. Windle	Superintendent [2]	L. J. Windle [2]	W. J. Burke	Billings, Mont.
Heart Mountain division	Cody, Wyo	Walter F. Kemp	Construction engineer	L. J. Windle [2]	W. J. Burke	Billings, Mont.
Sun River	Fairfield, Mont	A. W. Walker	Superintendent		W. J. Burke	Billings, Mont.
Truckee River Storage	Reno, Nev	Floyd M. Spencer	Construction engineer [2]		J. R. Alexander	Salt Lake City, Utah.
Tucumcari	Tucumcari, N. Mex	Harold W. Mutch	Resident engineer	Charles L. Harris	H. J. S. Devries	El Paso, Tex.
Umatilla (McKay Dam)	Pendleton, Oreg	C. L. Tice	Reservoir superintendent		B. E. Stoutemyer	Portland, Oreg.
Uncompahgre: Repairs to canals	Montrose, Colo	Herman R. Elliott	Construction engineer [2]	Ewalt P. Anderson	J. R. Alexander	Salt Lake City, Utah.
Upper Snake River Storage [3]	Ashton, Idaho	I. Donald Jerman	Construction engineer [2]	Emmanuel V. Hillius	B. E. Stoutemyer	Portland, Oreg.
Vale	Vale, Oreg	C. C. Ketchum	Superintendent		B. E. Stoutemyer	Portland, Oreg.
Yakima	Yakima, Wash	J. S. Moore	Superintendent	Conrad J. Ralston	B. E. Stoutemyer	Portland, Oreg.
Roza division	Yakima, Wash	Charles E. Crownover	Construction engineer	Alex S. Harker	B. E. Stoutemyer	Portland, Oreg.
Yuma	Yuma, Ariz	C. B. Elliott	Superintendent	Jacob T. Davenport	R. J. Coffey	Los Angeles, Calif.

[1] Boulder Dam and Power Plant.
[2] Acting.
[3] Island Park and Grassy Lake Dams.

Projects or divisions of projects of Bureau of Reclamation operated by water users

Project	Organization	Office	Operating official		Secretary	
			Name	Title	Name	Address
Baker (Thief Valley division) [1]	Lower Powder River irrigation district	Baker, Oreg	A. J. Ritter	President	F. A. Phillips	Keating
Bitter Root [4]	Bitter Root irrigation district	Hamilton, Mont	G. R. Walsh	Manager	Elsie H. Wagner	Hamilton.
Boise [1]	Board of Control	Boise, Idaho	Wm. H. Tuller	Project manager	L. P. Jensen	Boise.
Boise [1]	Black Canyon irrigation district	Notus, Idaho	W. H. Jordan	Superintendent	L. M. Watson	Caldwell.
Burnt River	Burnt River irrigation district	Huntington, Oreg	Edward Sullivan	President	Harold H. Hursh	Huntington.
Frenchtown	Frenchtown irrigation district	Frenchtown, Mont	Edward Donlan	President	Ralph P. Schaffer	Huson.
Fruitgrowers Dam	Orchard City Irrigation Co.	Austin, Colo	S. F. Newman	Superintendent	A. W. Lanning	Austin.
Grand Valley, Orchard Mesa [3]	Orchard Mesa irrigation district	Grand Junction, Colo	C. W. Tharp	Superintendent	C. J. McCormick	Grand Jctn.
Humboldt	Pershing County water conservation district	Lovelock, Nev	Roy F. Meffley	Superintendent	C. H. Jones	Lovelock.
Huntley [4]	Huntley irrigation district	Ballantine, Mont	E. E. Lewis	Manager	H. S. Elliott	Ballantine
Hyrum [3]	South Cache W. U. A.	Wellsville, Utah	B. L. Mendenhall	Superintendent	Harry C. Parker	Logan.
Klamath, Langell Valley [1]	Langell Valley irrigation district	Bonanza, Oreg	Chas. A. Revell	Manager	Chas. A. Revell	Bonanza.
Klamath, Horsefly [1]	Horsefly irrigation district	Bonanza, Oreg	Henry Schmor, Jr	President	Dorothy Eyers	Bonanza.
Lower Yellowstone [4]	Board of Control	Sidney, Mont	Axel Persson	Manager	Axel Persson	Sidney.
Milk River: Chinook division [4]	Alfalfa Valley irrigation district	Chinook, Mont	A. L. Benton	President	R. H. Clarkson	Chinook.
	Fort Belknap irrigation district	Chinook, Mont	H. B. Bonefright	President	L. V. Bogy	Chinook.
	Zurich irrigation district	Harlem, Mont	C. A. Watkins	President	H. M. Montgomery	Chinook.
	Harlem Irrigation district	Harlem, Mont	Thos. M. Everett	President	Geo. H. Tout	Harlem.
	Paradise Valley irrigation district	Zurich, Mont	R. E. Musgrove	President	J. F. Sharples	Zurich.
Minidoka: Gravity [1]	Minidoka irrigation district	Rupert, Idaho	Frank A. Ballard	Manager	O. W. Paul	Rupert.
Pumping	Burley irrigation district	Burley, Idaho	Hugh L. Crawford	Manager	Frank O. Redfield	Burley.
Gooding [1]	Amer. Falls Reserv. Dist. No. 2	Gooding, Idaho	S. T. Baer	Manager	Ida M. Johnson	Gooding.
Newlands [3]	Truckee-Carson irrigation district	Fallon, Nev	W. H. Wallace	Manager	H. W. Emery	Fallon.
North Platte: Interstate division [4]	Pathfinder irrigation district	Mitchell, Nebr	T. W. Parry	Manager	Flora K. Schroeder	Mitchell.
Fort Laramie division [4]	Gering-Fort Laramie irrigation district	Gering, Nebr	W. O. Fleenor	Superintendent	C. G. Klingman	Gering.
Fort Laramie division [4]	Goshen irrigation district	Torrington, Wyo	Floyd M. Roush	Superintendent	Mary E. Harrach	Torrington.
Northport division [4]	Northport irrigation district	Northport, Nebr	Mark Iddings	Manager	Mabel J. Thompson	Bridgeport.
Ogden River	Ogden River W. U. A.	Ogden, Utah	David A. Scott	Superintendent	Wm. P. Stephens	Ogden.
Okanogan [1]	Okanogan irrigation district	Okanogan, Wash	Nelson D. Thorp	Manager	Nelson D. Thorp	Okanogan.
Salt Lake Basin (Echo Res.) [3]	Weber River Water Users' Assn	Ogden, Utah	D. D. Harris	Manager	D. D. Harris	Layton.
Salt River [2]	Salt River Valley W. U. A.	Phoenix, Ariz	H. J. Lawson	Superintendent	F. C. Henshaw	Phoenix.
Sanpete:						
Ephraim division	Ephraim Irrigation Co	Ephraim, Utah	Jos. H. Thomson	President	John K. Olsen	Ephraim.
Spring City division	Horseshoe Irrigation Co.	Spring City, Utah	Vivian Larson	President	James W. Blain	Spring City
Shoshone: Garland division [4]	Shoshone irrigation district	Powell, Wyo	Paul Nelson	Acting irri. supt	Harry Barrows	Powell.
Frannie division [4]	Deaver irrigation district	Deaver, Wyo	Floyd Lucas	Manager	R. J. Schwendiman	Deaver.
Stanfield	Stanfield irrigation district	Stanfield, Oreg	Leo F. Clark	Superintendent	F. A. Baker	Stanfield.
Strawberry Valley	Strawberry Water Users' Assn	Payson, Utah	S. W. Grotegut	President	E. G. Breeze	Payson.
Sun River: Fort Shaw division [4]	Fort Shaw irrigation district	Fort Shaw, Mont	C. L. Bailey	Manager	C. L. Bailey	Fort Shaw.
Greenfields division [4]	Greenfields irrigation district	Fairfield, Mont	A. W. Walker	Manager	H. P. Wangen	Fairfield.
Umatilla, East division [1]	Hermiston irrigation district	Hermiston, Oreg	E. D. Martin	Manager	Enos D. Martin	Hermiston.
West division [1]	West Extension irrigation district	Irrigon, Oreg	A. C. Houghton	Manager	A. C. Houghton	Irrigon.
Uncompahgre [3]	Uncompahgre Valley W. U. A.	Montrose, Colo	Jesse R. Thompson	Manager	H. D. Galloway	Montrose.
Upper Snake River Storage	Fremont-Madison irrigation district	Ashton, Idaho	H. G. Fuller	President	John T. White	St. Anthony.
Weber River	Weber River W. U. A.	Ogden, Utah	D. D. Harris	Manager	D. D. Harris	Ogden.
Yakima, Kittitas division [1]	Kittitas reclamation district	Ellensburg, Wash	C. C. Hughes	Acting manager	C. L. Sterling	Ellensburg.

[1] B. E. Stoutemyer, district counsel, Portland, Oreg.
[2] R. J. Coffey, district counsel, Los Angeles, Calif.
[3] J. R. Alexander, district counsel, Salt Lake City, Utah.
[4] W. J. Burke, district counsel, Billings, Mont.

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Sallie A. B Coe, *Editor*.

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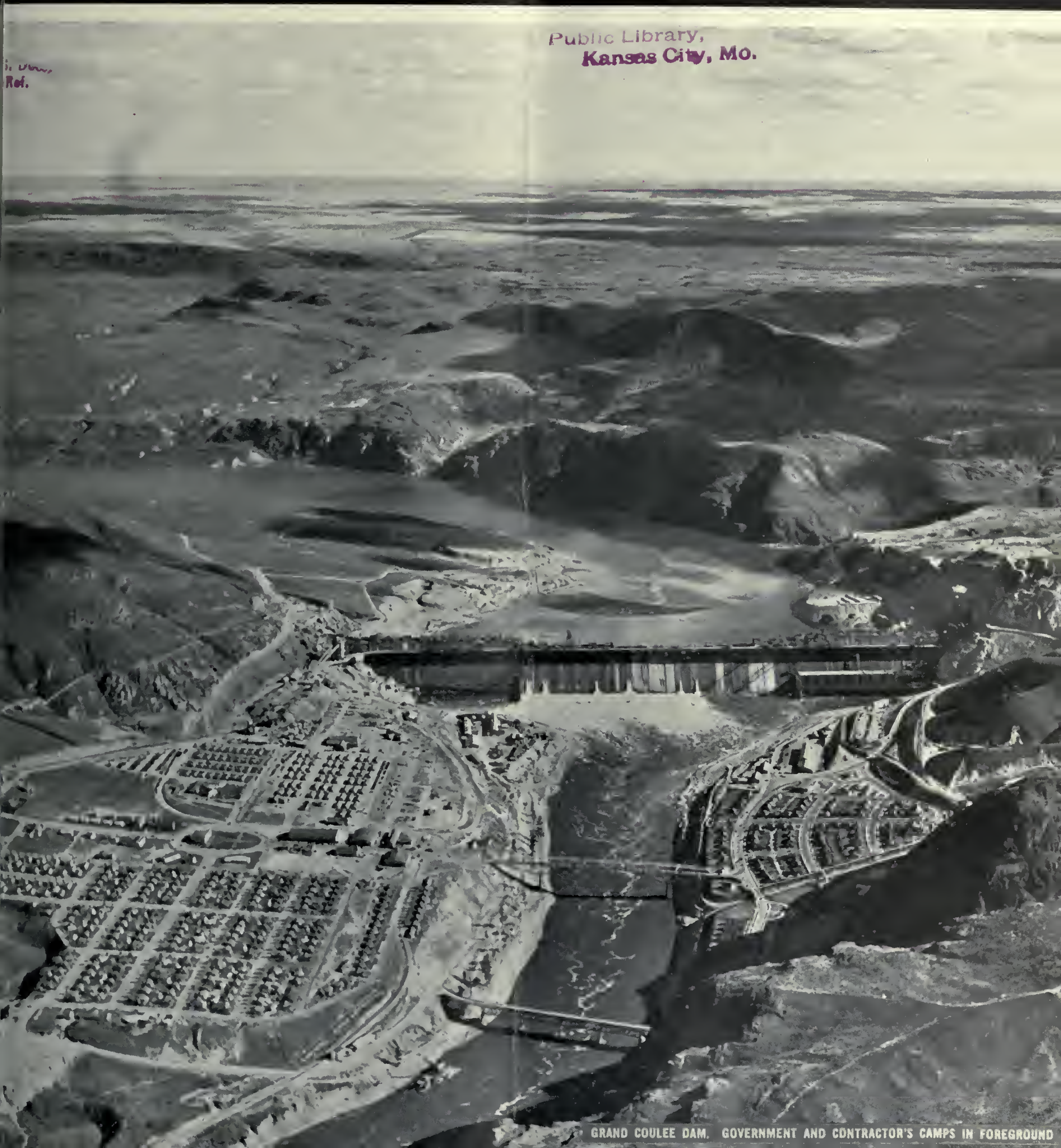

GRAND COULEE DAM. GOVERNMENT AND CONTRACTOR'S CAMPS IN FOREGROUND

An Anniversary Message

June 2, 1940, marks the thirty-eighth anniversary of the Federal Reclamation Act. It seems fitting to bring this to the attention of our readers. This policy for national development of two of our natural resources—land and water—is largely responsible for the upbuilding and peopling of the West where irrigation agriculture is a necessity because of scant rainfall.

The primary purpose of the Reclamation Act, and the intent of Congress in passing it, was the establishment of farms and homes. Let's see if this purpose has been lost sight of. There are 52,552 irrigated farms with a population of 226,969. Project towns number 258, with a population of 676,928. There are 944 schools and 1,133 churches. Bank deposits in banks on the projects or in project towns total $226,645,573.

The skill of the engineers who planned the great irrigation works which make possible these homes in the desert, and supervised the carrying out of the construction program, is commendable. The number of dams on Federal Reclamation projects now totals 145, of which 83 are storage dams and 62 diversion dams. Under construction are 13 additional storage dams and 2 diversion dams, which will bring the total to 160. Other achievements in the construction field are:

20,101	miles of canals and drains.
338	tunnels.
198,521	canal structures (flumes, culverts, bridges, etc.).
2,918	miles of road.
172	miles of railroad.
4,662	miles of telephone lines.
4,635	miles of power transmission lines.

In the planning and building of these reclamation projects not only the construction features have been conscientiously carried out, but much attention was given to the economic problems confronting a settler before and after he settled on a farm on a reclamation project. Some of the evils have been dealt with by legislation, such as purchase of land at speculative prices; large land holdings; and inexperience in irrigation farming. While speculation in land values is not completely controlled, on the Bureau's latest undertaking, the Columbia Basin project, of which Grand Coulee is its storage dam, a special act of Congress protects settlers from speculative land prices by providing for the setting up of values at which land must be sold to prospective settlers. A water right is limited to specified maximum areas. By selective settlement only experienced farmers with capital are allowed to take up a farm unit.

In the huge construction program authorized to relieve unemployment, Federal Reclamation has been generously recognized in dollars and cents as a permanent development and a good national investment.

Looking back over 38 years of operation shows gratifying results and looking into the future we hope for support of this national policy in any program involving the development of national resources and adjustment of population in the agricultural field.

John C. Page,
Commissioner of Reclamation.

PRICE
ONE
DOLLAR
A YEAR

THE RECLAMATION ERA

VOLUME 30 • JUNE 1940 • NUMBER 6

The Place of Hydroelectric Power in Reclamation

THE capacity of hydroelectric power plants on irrigation developments built by the Bureau of Reclamation in its water conservation work is statistically imposing. The 23 plants operating on the projects at the beginning of 1940 had one-fifth of the entire installed hydroelectric capacity in the West.[1] They had an installed capacity of 847,412 kilowatts, and an ultimate capacity of 1,471,712 kilowatts, compared with the 4,461,618 kilowatts reported for the entire region as of November 26, 1939, by the Federal Power Commission.

In addition, 15 power plants, with an ultimate capacity of 2,714,400 kilowatts, were under construction on Federal Reclamation projects. When completed they will bring the total capacity of power plants on Bureau of Reclamation projects to 4,186,112 kilowatts—almost equaling the present entire western hydroelectric development.

Imposing as the place of power on these projects may seem, however, the primary achievements of the Bureau of Reclamation are in the field of irrigation.

Generation of power on Reclamation projects is and always has been a byproduct of the larger objective: The irrigation and development of waste desert lands, and the preservation of lands already under irrigation and highly developed, by means of a supplemental water supply. It is, however, an integral part of the work done by the Bureau to conserve the West's most valuable natural resource, its water.

The Bureau of Reclamation has built 138 storage and diversion dams on irrigation projects, and 15 more are under construction. It has constructed more than 20,000 miles of canals, ditches, and drains; 4,600 miles of telephone lines; 13,000 bridges; and almost 200,000 other irrigation structures.

These dams, canals, and other permanent irrigation structures provide water for fully 3,000,000 acres of arid land. Richly productive, this land gives support to approximately a million Americans whose homes and farms, villages and towns represent an investment of three-quarters of a billion dollars, whose annual crop production is valued at more than $100,000,000, and whose needs create an annual market for American business worth more than $200,000,000.

A historical review of Reclamation power-plant construction helps to shed additional light on the place of power in Reclamation work. The sole reason for building the first power plant on a Reclamation development—the Roosevelt plant on the Salt River Valley project, Arizona, in 1906—was to provide the power needed in the construction of the project. The second plant—the Spanish Fork power plant on the Strawberry Valley project in Utah, in 1908—was built for the same reason. As time went on, still other projects similarly required power for their construction and necessitated the building of hydroelectric plants to provide it.

These small hydroelectric plants were included as a part of the cost of the project, to be repaid along with the other costs by the irrigation farmers. When the particular construction work itself was complete—such as the Roosevelt Dam on the Salt River project and the Strawberry Tunnel on the Strawberry Valley project—the plants were continued in operation.

The electricity was needed and welcomed in other channels. The plants supplied the current for operating the permanent structures of the projects, for lighting the homes and farm buildings of the irrigation farmers on the projects, and for operating their electric motors and other appliances.

As the demand for water conservation grew, however, and Reclamation projects became progressively larger and more complex, a new need developed. It became necessary to provide power for pumping for irrigation and drainage.

To meet this need, essential to the success of the irrigation projects, other plants were built. The Black Canyon power plant, completed in 1925, now used primarily for pumping water on the Owyhee project in Idaho and Oregon, is an example.

Plants of this type were designed as part of the irrigation works. In addition to their pumping and drainage work, however, they supplied electric energy to project structures and project homes, stores, and farms. And like those earlier power plants that were built for construction power, they helped also to meet the demand from industries growing up around the projects for low cost energy.

Production of power needed for pumping and drainage, the second phase of hydroelectric plant construction by the Bureau of Reclamation, was followed by a third phase.

First Multi-Purpose Project

The beginning of the third phase might be placed in the year 1928, when the Boulder Canyon Project Act was approved by the Congress.

The approval of this project, which was to include construction of Boulder Dam and the largest power plant in the world, signified a marked advance in the concept of conservation. Reclamation construction for the conservation of the Nation's water resources now definitely embraced the idea of the multi-purpose project.

Boulder Dam not only makes possible the irrigation of desert land along the Colorado River with water diverted by other smaller dams built for that purpose; not only makes possible a regulated supply of water for the irrigation of highly developed and richly productive lands in the Imperial Valley of California and elsewhere; not only makes possible the control of the river itself, reducing destructive floods to relatively harmless high waters; not only makes possible the supply of a billion gallons of domestic water a day to Los Angeles and a dozen other California coastal cities; but also generates large blocks of hydroelectric power.

The generation and sale of power can return revenues—revenues which can help de-fray the cost of a reclamation project—to offset part of the construction costs charged to irrigators for their water.

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[1] Seventeen States: North Dakota, South Dakota, Nebraska, Kansas, Oklahoma, Texas, New Mexico, Arizona, Colorado, Utah, Nevada, Wyoming, Montana, Idaho, Washington, Oregon, and California.

When plans for the Boulder Canyon project were under consideration, the volume of power which could be produced by a power plant at Boulder Dam and the revenue it could return to the United States Government to repay the investment were adjudged large enough to make the project a paying proposition. Therefore, because of the power it could produce, the project became—as all Reclamation projects must be before construction is approved—economically feasible.

In a multi-purpose project of the Bureau of Reclamation, irrigation remains the dominant objective, either to supply water to create new communities or to furnish supplementary water desperately needed by old communities whose welfare hangs in the balance. But other purposes of the project, such as flood control, river regulation, navigation, domestic water supply, and power, are the very purposes which may make the much-wanted irrigation project economically feasible and so, possible under the Reclamation law.

The Reclamation Project Act of 1939 fully recognizes this broader basis for irrigation construction. Under this law costs of such construction are allocated according to benefits. To irrigation is allocated only its particular share of the cost, to be repaid in 40 years and, in concession to national considerations, without interest. A share is allocated to power, when included, to be repaid also, but with interest at a rate not less than 3 percent. Proportionate shares are allocated to other benefits such as flood control and domestic water supplies when these are included.

The failure to make multiple use of the water not only would be wasteful but contrary to the larger public interest.

During the fiscal year 1939, power plants operating on Bureau of Reclamation projects sold 2,056,787,606 kilowatt-hours for $5,610,847.

This power revenue compares with the receipt of $2,165,934 as Reclamation project construction payments, $1,164,932 as operation and maintenance collections, and $363,377 as water rental receipts, a total of $3,694,245.

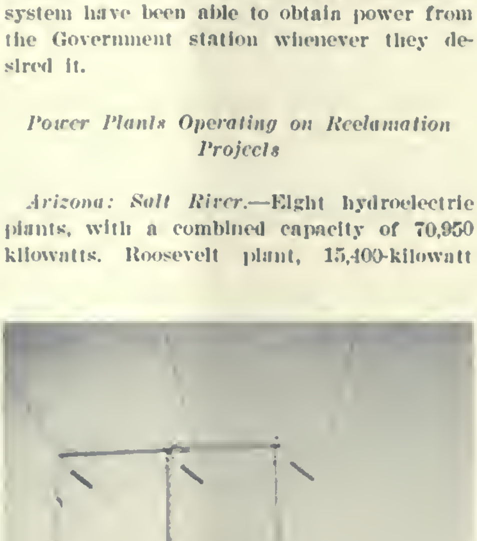
Sale of Electric Power

Two other aspects of the power question deserve notice. First, electric energy generated by power plants on Reclamation projects is sold wholesale. Second, under the law governing the sale of this electric energy, preference must be given to municipalities and other public corporations or agencies, cooperatives, and other nonprofit organizations. This is preference in the right to buy, not in price, since the Bureau of Reclamation must return to the United States the cost of its projects and therefore has the responsibility of obtaining a fair return. The price to both public agencies and private utilities is the same for the same class of service.

At present the Bureau of Reclamation has nearly 100 principal contracts for the sale of power generated on its projects. These are divided about equally, half being with public agencies and half with privately owned utilities. It is worthy of note that public agencies within the economic service area of a project system have been able to obtain power from the Government station whenever they desired it.

Power Plants Operating on Reclamation Projects

Arizona: Salt River.—Eight hydroelectric plants, with a combined capacity of 70,950 kilowatts. Roosevelt plant, 15,400-kilowatt capacity, was built by the Bureau of Reclamation to provide power for the construction of Roosevelt Dam. The seven other plants, built by the Salt River Valley Water Users' Association are: Horse Mesa, capacity 30,000 kilowatts; Stewart Mountain, 10,400; Mormon Flat, 7,000; Cross Cut, 5,100; South Consolidated, 1,600; Arizona Falls, 850; Chandler, 600. The first three of these seven plants are at dams; the other four use canal drops. They furnish power for irrigation pumping and commercial sale to cities, farms, and mines. Power marketing and disposal of revenue are controlled by the association, subject to the primary obligation to repay the funds invested by the Government in construction of the project.



Power being transmitted across an irrigated field to homes on land to be benefited by Seminoe Dam and power plant

Arizona-California: Yuma, Siphon Drop plant.—Capacity 1,600 kilowatts. The plant has two units rated at 800 kilowatts each using a drop in canal grade of approximately 10 feet. The All-American Canal will increase the power head to 14 feet, which will make possible an output up to the rated capacity Power is supplied to the drainage pumps on the valley division and irrigation pumps on the Yuma Mesa. The cost of the power has been charged against the water users' organizations and all revenues from power are applied to the repayment of project construction costs. Power over that required fo pumping and drainage is bought by the Nevada-California Electric Corporation a $0.006 per kilowatt from 8 a. m. to 8 p. m and $0.001 per kilowatt from 8 p. m. to 8 a. m

Arizona-Nevada: Boulder Canyon, Boulde Dam plant.—Installed capacity, 700,000 kilowatts; ultimate capacity, 1,317,500 kilowatts The power plant equipment is installed and owned by the United States, but a separate charge for the amortization of the investmen is made on the basis of the equipment installed for each contractor. Under presen conditions of river flow and reservoir capacity there are available 4,312,000,000 kilowatts o firm energy and an estimated average o 1,654,000,000 kilowatts of secondary energ annually. Firm energy is sold at $0.00163 pe kilowatt-hour. Secondary energy, on which the Metropolitan Water District has firs option for pumping purposes, is sold at $0.000 per kilowatt-hour. All energy is sold as falling water, and therefore certain purchaser operate and maintain the power plant equipment. Operation of the power plant, which i performed by the city of Los Angeles for the public agencies and by the Southern Californi Edison Co. for itself and the Nevada-California Electric Corporation, is at the expense o the power contractors. The California Powe Utilities Co. and the Citizens Utilities Co. ar served by the equipment operated by the city of Los Angeles because they take energy contracted for but temporarily not required by the Metropolitan Water District.

Colorado: Grand Valley, Grand Valley plant.—Capacity, 3,000 kilowatts, consisting o two 1,500-kilowatt generators operating unde a head of 73 to 79 feet. This plant was buil with funds advanced by the Public Service Co of Colorado, to which it is leased for 25 years Operation and maintenance of the plant i borne by the company. The company has the right to install at its expense additional generating units to use the irrigation capacity i the canal during the nonirrigation season. A the expiration of the lease such units revert to the United States with the rest of the plant Title to transformers and transmission facilities is held by the company. The company makes a minimum annual payment of $15,44 for power of which $12,000 is paid directly to the Government to apply on project construction costs with the balance paid to the Grand Valley Water Users Association for operation and maintenance. The United States and the association have the right to buy power for irrigation pumping on the projec at a price of $0.004 per kilowatt-hour at the plant or $0.00425 at any place on the company's transmission system.

Idaho: Boise project.—Two plants, Black Canyon, with a capacity of 8,000 kilowatts, and Boise River, with a capacity of 1,875 kilowatts. The Black Canyon plant has an installation of two 4,000-kilowatt units operating under a head of 93 feet, located at Black Canyon Dam, the diversion dam for the Payette Division and the Emmett Irrigation District. The Boise River plant has an installation of three 625-kilowatt units located at the diversion dam for the project's main canal. The Black Canyon plant was built to supply power for pumping water on the Gem Irrigation District. The Boise plant was built to provide construction power in building Arrowrock Dam.

The Boise plant is not operated in the winter because it is necessary to store the winter flow of the Boise River for irrigation. The plant is operated intermittently during the irrigation season whenever there is enough demand for power to justify the expense of operation, which is twice as much per kilowatt-hour as operating the Black Canyon plant. For this reason the Boise plant is held in reserve most of the time as a standby plant, and is put into operation only when there is a greater demand for power than can be supplied from the Black Canyon plant.

Sixty-seven percent of the installed power capacity of the project is sold to public agencies—the irrigation districts of the Owyhee project and the Emmett Irrigation District. Surplus power is sold to the Idaho Power Co. During the 1939 fiscal year, 23,148,270 kilowatt-hours were sold to public agencies and 38,386,693 kilowatt-hours to the Idaho Power Co.

Minidoka project, Minidoka plant.—Capacity 10,000 kilowatts, consisting of three 1,400-kilowatt units, two 1,600-kilowatt units and one 2,600-kilowatt unit, operating under a maximum head of 50 feet. The plant was built in 1909 at Minidoka Diversion Dam to provide power for pumping on the Burley division. It has been enlarged several times, and another unit of 5,000 kilowatts is now being installed. The demands for power for irrigation pumping on the project, mainly in the Burley Irrigation District, have grown to such an extent that the irrigation pumping requirements alone now require all and sometimes even more power than available, leaving no firm power for the extensive commercial power business on the project. This demand is met by an arrangement with the Idaho Power Co., which delivers power to the Minidoka project in exchange for that received by the company from the Black Canyon plant of the Boise project.

Contracts exist with 16 public agencies to which 40 percent of the installed capacity is sold. During the 1939 fiscal year sales to public agencies amounted to 59,099,800 kilowatt-hours at $.00305 per kilowatt-hour.

Six 82,500 kilovolt-ampere generators, biggest in the world, in the Nevada wing of the powerhouse at Boulder Dam, with one in the Arizona wing, produce power amounting to 130,000,000 kilowatt-hours of energy each month which sells for $290,000

Nebraska-Wyoming: North Platte project.—Two plants, Guernsey, capacity 4,890 kilowatts, and Lingle, capacity 1,750 kilowatts. The Guernsey plant is located at Guernsey Dam. It has an installation of two 2,400-kilowatt units operating under a maximum head of 90 feet. The Lingle plant has an installation of two 500-kilowatt units and two 375-kilowatt units, receiving water from Fort Laramie Canal, operating under a head of 106 feet. Both plants supplied power for construction of Seminoe and Alcova Dams. Power revenues are credited to annual construction charges. In recent years power revenues amounted to 60 percent of the total construction payment due. Contracts exist with 14 public agencies which during the fiscal year 1939 bought 9,275,787 kilowatt-hours at $0.0155 per kilowatt-hour. There are contracts with 5 private companies which during the fiscal year 1939 bought 15,372,170 kilowatt-hours at $0.0084 per hour. The larger private power contractors have generating equipment of their own and consequently a large part of the power sold to them is secondary.

Nevada: Newlands project, Lahontan plant.—Capacity 1,500 kilowatts, consisting of three 500-kilowatt units, located downstream from Lahontan Dam. The maximum head is 125.6 feet when water is supplied from the

Truckee Canal and 111 feet when water is supplied from Lahontan Reservoir. Operation and maintenance of the project, including the power plant, has been turned over to the Truckee-Carson Irrigation District, the project water users' organization. Power sales are thus under the direct control of the district. Power is supplied to the town of Fallon and other communities.

Utah: Strawberry Valley project, Spanish Fork plant.—Capacity 1,150 kilowatts, consisting of two 450-kilowatt units and one 250-kilowatt unit. Power capacity of 250 second-feet is provided in the Highline Canal and a head of 125 feet is available in a drop to the Salem Canal. The cost of the power system became part of the repayment obligation of the Strawberry Valley Water Users' Association which took over operation of the power system in 1927. The plant supplies power to several corporations and project towns among them Payson City and Spanish Fork.

Washington: Yakima project.—Two plants, Prosser, with a capacity of 3,000 kilowatts, consisting of one unit operating at a head of approximately 40 feet, and Rocky Ford of 187 kilowatts operating at a head of 73 feet.

DATA ON POWER PLANTS

Cost data and distribution of power generated on Bureau of Reclamation projects as of June 30, 1939

Project	Name of power plant	Total cost of—			Distribution of power generated in kilowatt-hours					
		Power plant	Transmission system	Substations	Sold to consumers	Used for irrigation and drainage pumping	Used for other purposes	Losses	Total generated for year	Gross income from sale of power (U. S. and commercial)
Boise	Black Canyon	$414,317.21	(1)	(1)	37,169,703	26,064,305	1,097,656	1,311,275	[2] 65,642,939	[2] $83,582.0
	Boise River	167,905.37	(1)	(1)	(3)	(3)	(3)	(3)	4,804,480	(3)
Boulder Canyon	Boulder	25,175,829.40	$68,325.70	$76,335.88	1,646,016,171	None	15,898,983	15,001,091	1,676,946,245	2,388,995.9
Grand Valley	Grand Valley	210,500.00	(4)	(4)	(4)				8,597,970	
Minidoka	Minidoka	784,778.13	190,959.92	134,457.81	23,223,600	35,865,644	15,212,920	4,038,764	78,340,928	185,654.3
Newlands	Lahontan	298,446.87	26,346.65	(6)	4,575,273	11,110	64,548	480,739	5,131,670	41,775.7
North Platte	Guernsey	[7] 454,244.27	368,547.62	8,822.27	24,612,571	35,786	275,250	2,234,283	18,218,100	[8] 293,613.8
	Lingle	[7] 184,791.74	(9)	(9)	(9)	(9)	(9)	(9)	8,939,790	(9)
Riverton	Pilot Butte	222,157.82	117,365.68	16,864.35	1,982,475		519,051	70,794	2,572,320	36,225.7
Salt River	Roosevelt Horse Mesa Stewart Mountain Morman Flat Cross Cut South Consolidated Arizona Falls Chandler	[10] 12,114,465.00	[10] 4,320,443.00	[10] 1,751,420.00	[10] 271,434,381	[10] 61,953,188	[10] 443,686	[10] 69,484,516	[10] [11] 290,373,870	2,328,525.9
Shoshone	Shoshone	745,005.72	117,693.77	20,337.99	11,566,001		37,262	1,227,737	12,831,000	108,828.1
Strawberry Valley	Spanish Fork	180,217.93	(12)	(12)	5,794,468		57,469	213,601	[13] 5,544,738	60,703.0
Yakima, Kennewick division	Prosser	388,625.00	16,219.00		[14] 23,303,750		43,225	413,665	23,760,640	[15] 41,326.6
Sunnyside division	Rocky Ford	23,059.00	3,495.00			[16] 689,400			[16] 689,400	
Yuma	Siphon Drop	317,936.09		4,592.44	[17] 7,079,313	1,934,000	103,738	450,088	9,567,139	41,615.7
Total					2,056,787,606	126,563,433	33,310,102	94,926,545	2,211,961,229	5,610,847.1

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[1] Included.
[2] Includes power generated at Boise River power plant.
[3] Included with Black Canyon power plant data.
[4] Owned by lessee.
[5] Not included.
[6] Included in transmission system cost.
[7] Plus cost of power canal, cottages, garages, and road, $37,221.50.
[8] Excludes revenue from Whalen Dam and building rentals, $2,439.07.
[9] Included in data on Guernsey power plant.
[10] Total for system.
[11] Exclusive of Diesel power, 22,697,800 kilowatt-hours and power purchased, 90,244,10 kilowatt-hours.
[12] Included in cost of power plant.
[13] Exclusive of power purchased, 520,800 kilowatt-hours.
[14] Includes 4,800,000 kilowatt-hours of winter power delivered to Pacific Power & Light Co in payment for transmission of power to irrigation districts.
[15] Includes income of $28.30 from use of power at powerhouse foreman's cottage.
[16] For calendar year 1938.
[17] Includes 1,705,400 kilowatt-hours used by Yuma auxiliary project for irrigation pumping.

Operated on Bureau of Reclamation Projects as of January 1, 1940

Project	Name of power plant	Operated by—	Located on—(river)	Near town of—	Year of installation, initial unit	Total installed generating capacity in kilowatts	Estimated average annual potential output in kilowatt-hours
Boise	Black Caynon	U. S. Bureau of Reclamation	Payette	Emmett, Idaho	1925	8,000	62,000,00
	Boise River	do	Boise	Boise, Idaho	1912	1,875	3,000,00
Boulder Canyon	Boulder	Bureau of Power & Light of Los Angeles and The Southern California Edison Co.	Colorado	Boulder City, Nev	1936	700,000	3,100,000,00
Grand Valley	Grand Valley	Public Service Co. of Colorado	do	Palisade, Colo	1932	3,000	8,000,00
Kendrick	Seminoe	U. S. Bureau of Reclamation	North Platte	Rawlins, Wyo	1939	32,400	140,000,00
Minidoka	Minidoka	do	Snake	Rupert, Idaho	1909	10,000	81,750,0
Newlands	Lahontan	Truckee-Carson Irrigation District	Carson	Lahontan, Nev	1911	1,500	5,730,0
North Platte	Guernsey	U. S. Bureau of Reclamation	North Platte	Guernsey, Wyo	1927	4,800	18,000,0
	Lingle	do	Fort Laramie Canal	Lingle, Wyo	1918	1,750	9,000,0
Riverton	Pilot Butte	do	Wyoming Canal	At head of Pilot Butte Reservoir, Wyo.	1925	1,600	4,200,00
Salt River	Roosevelt	Salt River Valley Water Users' Association	Salt	Globe, Ariz.	1906	15,400	42,550,00
	Horse Mesa	do	do		1927	30,000	110,000,0
	Stewart Mountain	do	do		1930	10,400	20,000,0
	Mormon Flat	do	do		1926	7,000	40,000,0
	Cross Cut	do	Cross Cut Canal	Tempe, Ariz	1914	5,100	11,900,0
	South Consolidated	do	South Consolidated Canal.	Lehi, Ariz	1912	1,600	6,500,00
	Arizona Falls	do	Arizona Canal	Scottsdale, Ariz	1913	850	2,500,00
	Chandler	do	Chandler Cross Cut	Mesa, Ariz	1919	600	2,400,00
Shoshone	Shoshone	U. S. Bureau of Reclamation	Shoshone	Cody, Wyo	1922	5,600	45,000,00
Strawberry Valley [1]	Spanish Fork	Strawberry Water Users' Association	Spanish Fork	Spanish Fork, Utah	1908	1,150	5,500,00
Yakima, Kennewick division.	Prosser	U. S. Bureau of Reclamation	Yakima	Prosser, Wash	1932	3,000	26,280,00
Sunnyside division	Rocky Ford	Grandview Irrigation District, under Government supervision.	Rocky Ford Canal	Grandview, Wash	1917	187	960,00
Yuma	Siphon Drop	U. S. Bureau of Reclamation	Project Main Canal	Yuma, Ariz	1926	1,600	6,400,00
Total						847,412	3,757,670,00

[1] Owned by lessee.

Both plants were built to furnish power for irrigation pumping. All power in excess of that required for irrigation pumping is bought by the Pacific Power & Light Co. at a flat rate of $0.002 per kilowatt-hour for irrigation season power and $0.0015 for nonirrigation power, except that 4,800,000 kilowatt-hours of nonirrigation season energy is supplied to the company as compensation for transmitting power to the irrigation districts.

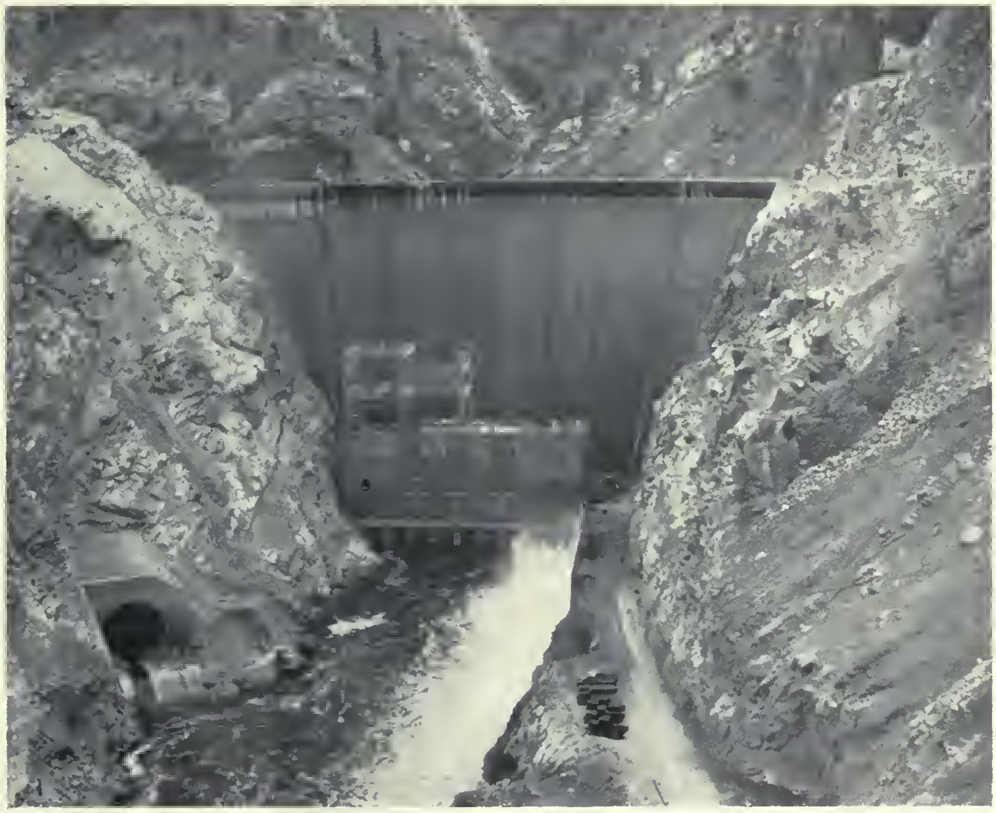
Wyoming: Kendrick project, Seminoe plant.—Capacity, 32,400 kilowatts consisting of three 10,800-kilowatt units. The plant, located at Seminoe Dam, started operation in August 1939. All available firm and secondary power had previously been contracted for disposition to municipalities and private utilities.

About 400 miles of transmission lines have been energized. From Seminoe, a 33-kilovolt line extends 34 miles to Rawlins, Wyo.; a 66-kilovolt line 63 miles to Casper, Wyo.; and a 115-kilovolt line 141 miles through Laramie to Cheyenne, Wyo. At Cheyenne, one 115-kilovolt line extends north 94 miles to Gering, Nebr., connecting there with the North Platte project power system; another 115-kilovolt line extends south 53 miles to Greeley, to meet a power shortage in northeastern Colorado. The Greeley line will later provide a connection with the Colorado-Big Thompson project power system when completed.

Authorization has been granted for the construction of a 66-kilovolt line 120 miles long from Casper to Thermopolis, Wyo., which will interconnect the Shoshone-Riverton projects hook-up with that of the Kendrick-North Platte projects, and thus form a correlated power system to provide standby energy in case of shortage on any of the four projects and facilitate efficient usage of the available supply. Consideration is also being given to the desirability of building a line from Thermopolis to Cody, Wyo., to complete the circuit between the four projects.

Riverton project, Pilot Butte plant.—Capacity, 1,600 kilowatts, consisting of two 800-kilowatt units, operating under a head of 90 to 105 feet. The plant was built to provide power for construction of the project. Contracts are in existence with one public agency and four private companies. No deliveries of energy have been made to the public agency. Sales to private companies during the fiscal year 1939 amounted to 2,181,585 kilowatt-hours at $0.0154 per kilowatt-hour. Diversions to the Pilot Butte Reservoir on the Riverton project are made at the power plant so that water used for power may be retained and used for irrigation.

Shoshone, Shoshone plant.—Capacity, 5,600 kilowatts, consisting of one 4,000-kilowatt unit and two 800-kilowatt units. The plant is located at Shoshone Dam. Contracts exist with five public agencies and three private companies. During the fiscal year 1939 the public agencies bought 440,491 kilowatt-hours of firm power at $0.0183 per kilowatt-hour and the private companies bought 11,104,182 kilowatt-hours of secondary power at $0.009 per kilowatt-hour. A reduction in rates was put into effect during the fiscal year 1939. The reduction is reflected in figures for the first half of the fiscal year 1940 when public agencies used 318,471 kilowatt-hours at $0.0154 per kilowatt-hour, and private companies used 5,554,456 kilowatt-hours of secondary power at $0.0084. Power from Shoshone is being used on construction of the Heart Mountain division of the project and is also being distributed to all principal towns in the Big Horn Basin by the Mountain States Power Co. which buys all surplus power. This contract covers about 95 percent of the plant's output.



Seminoe Dam and power plant, recently completed on the North Platte River

Power Plants Under Construction

Arizona-California: Parker Dam project, Parker Dam plant.—Ultimate capacity, 120,000 kilowatts. Three 30,000-kilowatt generators are now on order by the Government. It is expected the plant will be in operation by 1942. A fourth generator is planned when need for it arises. Under an agreement with the Metropolitan Water District of Southern California, which paid for construction of the dam, the power privilege at Parker Dam is shared equally between the United States and the District, with either party having the right to install generators to use the entire available water supply until such time as the other party desires to take over its share. The Government will operate the three generators now being installed until such time as the District cares to take over its share of the plant. Preference for the Government's share of the power is reserved for use on the Gila project and the Colorado River Indian Reservation; interim contracts for the sale of Parker power in the Phoenix area in Arizona have been executed; a 140-mile transmission line from Parker to Phoenix has been completed; one to Blaisdell, 116 miles long, is under construction; and extensions from Phoenix to Coolidge and Tucson are proposed. It is expected that the Metropolitan Water District will not require Parker Dam power for a number of years. Power for pumping domestic water through the Colorado River aqueduct to Los Angeles and 12 other southern California cities is now obtained from Boulder Dam's power plant. Estimated cost of the Parker Dam power project, $12,895,000.

California: All-American Canal.—Four power plants, with a combined capacity of 46,000 kilowatts, on canal power drops; under construction by the Imperial Irrigation District. Two plants are expected to go into operation as soon as water is made available in 1940; their combined capacity is 30,000 kilowatts.

Central Valley project, Shasta Dam plant.—Ultimate capacity, 375,000 kilowatts, consisting of five 75,000-kilowatt units. Initial installation will consist of four units, amounting to 300,000 kilowatts. The plant is expected to be in operation by 1944. Power from the Shasta plant will be transmitted to

(Continued on page 165)

Technical Investigations at Boulder Dam

By TOM C. MEAD, *Associate Engineer*

AT ALL large dams, inspections, surveys, and measurements are made for the purpose of observing performances under service conditions, and incidentally, to furnish information useful in the design of future dams. At Boulder Dam, part of the work of this nature has been classified as "technical investigations." The work is divided into three principal activities; namely, measurement of forces acting on the dam and their effects; observations of seepage; and assistance in a cooperative study of salinity, temperatures, density currents, and silt deposition in Lake Mead.

Observations in the field principally concern those factors or forces which cannot be predicted accurately prior to construction, or which should be checked to determine changes that might be detrimental to the structure. One of the forces not readily predictable is the earthquake thrust on the dam, a study of which is part of an extensive investigation of earthquake activity in the vicinity of Lake Mead, formed by Boulder Dam.

There is no evidence of recent earthquakes of destructive intensity in the Boulder Dam area; nevertheless, liberal allowances for earthquake shocks were included in analyzing stress conditions in the dam.

With the filling of the reservoir an increase in earthquake activity has been observed. Should strong shocks occur, preparations already made will permit measurements of their intensities. Three strong motion accelerographs have been placed in or near the dam to record shocks of such intensities as would probably cause plaster to crack. For recording light shocks, a single horizontal component Wood-Anderson seismograph was installed in Boulder City in February 1938. This instrument will be replaced soon by a more complete installation consisting of three instruments measuring motion vertically, and horizontally in two directions at right angles. In addition to the seismograph station at Boulder City, there will be two similar stations established near the shores of Lake Mead, so that the origin of shocks can be located as accurately as possible by seismic triangulation.

All Boulder Dam seismic work heretofore has been conducted with assistance from the United States Coast and Geodetic Survey. In future work, particularly the study of local shocks recorded at the three seismograph stations, the Bureau of Reclamation, National Park Service, and Coast and Geodetic Survey will cooperate. Thus, the investigation will have the advantage of the Geodetic Survey's leadership and experience in seismology. The National Park Service will service the two outlying stations to be located at some distance from Boulder City, while the Bureau of Reclamation will service the Boulder City station. The Park Service has on its staff several engineers and geologists whose interest in seismology will assure enthusiastic support. The Bureau of Reclamation is constructing vaults for the two outlying stations, and the Coast and Geodetic Survey is supervising the purchase of seismological instruments.

Resistance thermometer equipment

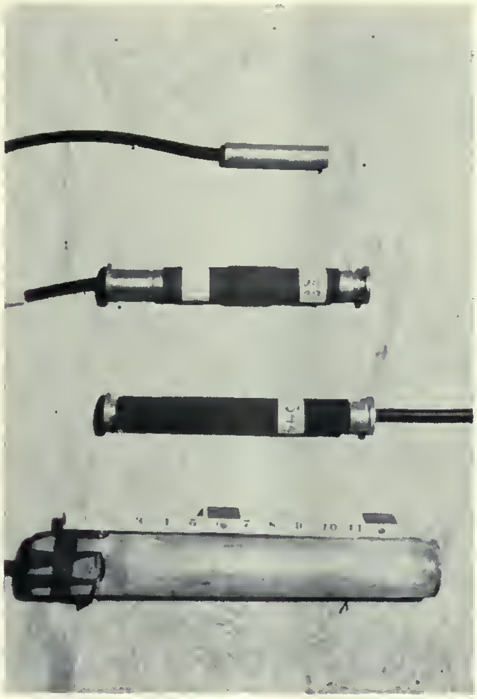
Included among the forces whose intensities could not be predicted, is the hydrostatic uplift pressure. Design studies included assumed uplift pressures, based largely on observed pressures in existing dams. Provisions were made in constructing the dam to keep these pressures as low as possible. Control of uplift was effected by thorough grouting of the foundations, abutments, and contraction joints, and by water seals along the contact of the upstream face with the abutments. A carefully planned system of drains was provided to carry away seepage. The foundation and abutments were grouted under the upstream edge of the dam by injecting a mixture of water and cement under pressure into diamond-drill holes, the purpose being to cut off, as much as possible, any seepage or flow through the rock. Drain holes were drilled downstream from the grouted zone, to tap any seepage which might find its way around or through the grouted zone.

To evaluate the effectiveness of initial grouting and drainage operations, and to determine later where remedial measures were desirable, installations for measuring uplift pressures were made at several locations. The measuring apparatus consisted of gages, located for convenience in an inspection gallery, and connected by piping to gravel pockets placed at locations where measurements were desired. The pockets were made by embedding sacks of coarse gravel on the contact surface of the foundation and in the concrete of the dam.

Some corrective grouting and drilling of additional drainage holes are now in progress where uplift pressure readings have indicated that conditions should be improved. Fortunately, in an arched-gravity dam such as Boulder, the presence of uplift pressures is not a threat to the safety of the structure. However, high uplift pressures would be objectionable under the comparatively lighter adjoining powerhouse structures.

Changes in Mass Concrete

During construction of the dam, elastic-wire, electrical strain gages were embedded in the concrete at a number of locations within the dam and connected by leads to terminal



Top to bottom, resistance thermometer, strainmeter, and jointmeter units, also strainmeter in case ready for installation

boards in the galleries. From observation of these instruments total strains can be determined. These strains give a satisfactory measure of the volume changes in mass concrete, but it has not yet been possible to isolate effects of all individual factors such as temperature variations, plastic flow, and reservoir load. Readings are obtained periodically from all strain meters and an excellent strain history of the dam has been obtained. Analyses have not yet been developed to the extent of determining stresses.

Joint meters which measure the opening of contraction joints have been embedded across certain joints in the dam and readings are being made periodically. A large number of resistance thermometers were embedded throughout the dam, from which temperatures of the concrete are determined. During construction the concrete was cooled to temperatures varying from 45° F. at the upstream face to 65° F. at the downstream face. These values are slightly below the estimated final stable temperature of the dam.

In the interior of the dam, the temperature of the mass concrete has risen about 10° in the 4 years since completion of construction. Most of this temperature rise is attributable to the generation of heat accompanying the continuing hydration of cement. Closer to the foundation surfaces, greater temperature rises have been observed, because of the diffusion of heat from the relatively warmer foundation rock.

At exposed surfaces of the dam seasonal variations govern the temperature of the concrete. Three automatic recorders give a continuous record of concrete surface temperatures which vary from freezing to 145° F. Surface temperatures of the concrete submerged by the lake are obtained by measuring lake temperatures with a resistance thermometer lowered to various depths from a boat.

In addition to joint meter observations, measurements of movements of the dam are made by the following methods:

(1) Precise surveys by methods of geodesy.

(2) Plumbing of elevator shafts.

(3) Extensometer measurement of openings between contraction joints on top of the dam and in some of the galleries.

(4) Weekly readings of tilt of concrete blocks within the galleries of the dam.

(5) A survey of cracks within the dam and on its outside surface.

The most interesting and perhaps the most significant of the precise surveys are those which locate with respect to a triangulation network, the position of targets spaced at fairly regular intervals over the downstream face of the dam. Locations of the targets are found by making angular measurements from a group of reference piers situated along the canyon walls. Some of the piers and reference points are far enough away from the dam to be unaffected by the thrust of the structure against the abutment rock. Considering these remote points as immobile, coordinates are transferred by triangulation to the piers nearest to the dam, and from the nearest piers accurate positions for the targets are computed from the angular observations.

In addition to locating the position of the downstream face of Boulder Dam, survey traverses on top of the dam in important galleries and in adits to tunnels, serve to reveal any horizontal bending or change in length, in a horizontal plane, of the dam itself or of the adjoining tunnels. Precise surveys of all stations are made twice a year.

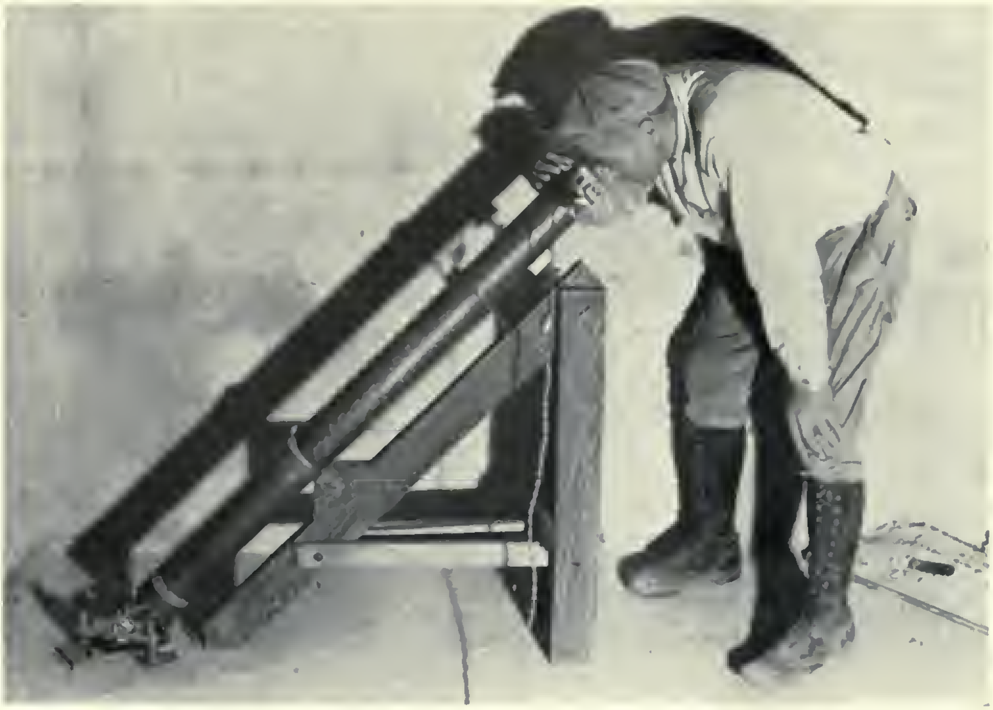
Elevator shaft plumbing, joint opening measurements, tilt readings, and crack surveys are supplementary to the survey showing movement of the dam as a whole. From the top of each of the two elevator shafts in the dam is suspended a steel piano wire supporting a 100-pound plumb bob at the bottom. Horizontal offset measurements are made weekly from this plumb line to buttons inserted at different elevations in the shaft walls. From these offset measurements movements of the shafts from week to week are easily determined. Supplementary plumbing measurements are also made by an optical method, in which offset measurements are made to the buttons from the vertical line of sight of a collimator, serving the same purpose as a plumb wire.

The operation of opening and closing contraction joints at selected locations in the upper levels of the dam is measured with an extensometer, at inserts placed on opposite sides of the joints. Further data on movements of the dam are furnished from measurements of tilt or angular movement at a number of points in the galleries of the dam. Tilt is measured with optical-type instruments especially developed for the purpose by Reclamation engineers. Still further data are furnished by record drawings showing the location and extent of opening all cracks observed in the galleries and shafts and on the faces of the dam. About four careful surveys are made each year for detection of additional cracks and for observations of previously detected cracks. These data are useful in studies which attempt to correlate the movement of the dam with the imposed loads and temperature changes.

Making readings through a telescope

Investigational Work

Quantities and temperatures of seepage are measured in the dam and downstream for a distance of about 2 miles. The first and most natural concern about seepage is its amount, but its point of emergence, temperature, and chemical character command attention when attempting to analyze the meaning of seepage changes. Along with uplift pressure, seepage is studied to determine the results of foundation drilling and grouting operations, and it is always watched in connection with changes in lake level. When practicable, seepage is measured close to the point where it issues from the rock, as its location helps to point out possible geologic imperfections such as seams, fissures, or porous regions. Fortunately the total quantity of seepage at Boulder Dam is small, and the foundation rock is not readily soluble. However, increasing attention is being paid to the chemical analyses of seepage water, which, together with water



Making tiltmeter readings through a special telescope

temperatures, serve as a clue to the origin of seepage. Knowledge of the composition of the seepage water should help also in understanding the reason for the deposition of calcium carbonate in the foundation drains.

A third type of investigational work includes the routine measurement of lake water temperatures midway between the upstream intake towers at the dam. It was found that a very finely divided silt is present, in suspension, along the bottom of Lake Mead, and that the temperature of this silty layer is surprisingly somewhat higher than that of the water above. Water sampling further revealed that the lake water is not mixed to a uniform composition but is stratified. Water carrying the most dissolved solids has found its level along the bottom.

Study of Density Current

Shortly after the existence of a silt layer at the bottom of the lake was discovered the Geological Survey, the Bureau of Standards, and other scientific organizations became interested in the nonuniformity of compositions of large bodies of water. Indeed, effects of temperature, dissolved solids, and silt not only cause stratification, but where conditions are appropriate, cause density current flows. Because of mutual interest in these phenomena, the Geological Survey, Bureau of Standards, Bureau of Fisheries, Metropolitan Water District of Southern California, some university representatives, and the Bureau of Reclamation began a study of density currents, using the National Research Council as a coordinating agency.

In the density current study of Lake Mead, cooperation between the Geological Survey and the Bureau of Reclamation has been very close. The Bureau of Reclamation has taken water samples which the Geological Survey and the Metropolitan Water District of Southern California have analyzed. Samples are taken at five designated stations on Lake

Wilde theodolite being used to observe canyon wall targets, one of the procedures in obtaining deformation of downstream face of the dam

Mead, and elsewhere when convenient. In ad
dition, the Bureau has observed lake wate
temperatures, conductances which give
rough measure of total dissolved solids, an
has taken water samples for determinatio
of specific gravity and silt samples for de
termination of particle sizes. Recently, meas
urement of currents has also been made wit
a current meter. At the present time muc
valuable data are being assembled whic
should reveal, among other things:

(1) The manner in which silt is being de
posited along the original river channel, in
cluding depth and particle size at the plac
of deposit;

(2) The manner in which lake water
stratified by temperature and solution of dis
solved minerals; and

(3) An explanation of the effects of storag
on the salinity of water released from Lak

Taking water sample which shows divi
sion line between a silty underflow an
clear water

Mead as compared with the salinity of th
original river water.

That the above-mentioned observations hav
application is demonstrated by the use o
Lake Mead temperature records in a stud
of the possible effects of storage on the lif
of salmon in the Sacramento River belo
Shasta Dam. Again, the Boulder City offic
has had to reply to Imperial Valley landown
ers who were disturbed by rumors that Lak
Mead was gradually becoming a salt lake
With the support of actual evidence fro
water sampling, the reply which could b
given was reassuring.

Technical investigations at Boulder Da
also included determining the damping facto

of the intake towers under submerged conditions, in connection with earthquake studies for the Pitt River bridge piers at Shasta Dam. Another special investigation consisted of vibration studies in 12-inch diameter models of new type needle valves. Results of the latter tests served to point out features needing improvement. The models were altered and retested until the tests indicated that the designs were adequate and could be safely extended to full-size valves.

Hydroelectric Power

(Continued from page 161)

a substation near Antioch. It will be used for pumping water into the lower end of the San Joaquin Valley and in the Contra Costa Canal which will carry water to the farming and industrial area on the south side of Suisun Bay. There will be a large quantity of energy in excess of these requirements for general marketing. The Central Valley project is a comprehensive program for full utilization of the Great Central Valley water resources. Flood waters of the Sacramento River will be stored in Shasta Reservoir and released during periods of low flow for improvement of navigation, for supplemental irrigation supplies, for the prevention of salt water encroachment, and for industrial use. San Joaquin River waters will be stored in Friant Reservoir for use in the upper San Joaquin Valley, while the lower San Joaquin Valley will be supplied water from Shasta Reservoir through the San Joaquin pumping system. No allocation of costs has been made.

What Boulder Dam is to the Southwest, and Grand Coulee Dam will be to the Northwest, Shasta Dam will be to California.

Colorado: Colorado-Big Thompson project.—Six plants, with an ultimate capacity of 137,600 kilowatts. One plant, located at Green Mountain Dam, is now under construction; it has a capacity of 21,600 kilowatts, consisting of two 10,800-kilowatt units. This plant is expected to be in operation by 1942. The five other plants, with a combined capacity of 116,000 kilowatts, will be constructed on the eastern slope of the Rocky Mountains as need arises and funds are made available. They will be operated by water diverted from the western slope through the Continental Divide Tunnel. When completed, the project will provide supplemental irrigation water to 615,000 acres of land now under cultivation with insufficient water supplies. Estimated cost to be repaid from power revenues, $29,288,000.

New Mexico-Texas: Rio Grande project, Elephant Butte plant.—Capacity, 24,300 kilowatts, now being installed, consisting of three 8,100-kilowatt units. It is expected that the plant will go into operation before the end of 1940. One-half of the plant's output has been allocated for use in Texas and the other half has been allocated to New Mexico. Power sale contracts are now being negotiated. Most of the power is expected to be taken by private companies, but all may be transferred to public agencies. The standard schedule of rates contemplates energy charges ranging from $0.01 to $0.003, depending on the amount used, plus a demand charge of $1.25 per kilowatt. The demand charge will be waived for distributors with existing fuel plants which they wish to maintain in service. Most of the power contractors will be able to take advantage of this concession. Estimated cost to be repaid from power revenues, $7,256,000.

Texas: Colorado River project, Marshall Ford plant.—Ultimate capacity, 67,500 kilowatts, consisting of three units of 22,500 kilowatts each, two of which are now being installed; under construction by the Lower Colorado River Authority.

Washington: Columbia Basin project, Grand Coulee plant.—Ultimate capacity, 1,944,000 kilowatts, consisting of eighteen 108,000-kilowatt units. Three units comprising the initial installation are now on order. They have a combined capacity of 324,000 kilowatts. The plant is expected to go into operation in 1942. Two station service units of 10,000 kilowatts each are also being installed. These units, which are expected to go into operation in 1940, will supply commercial power until their output is required for station service use, such as operating the dam and power plant machinery, the switchyards, and lighting the power plant. They will also provide power for the Government camp at Coulee Dam, and later, for the pumping plant. The cost of the entire power plant including transformers and switching stations is estimated at $71,000,000, but $130,000,000 is tentatively allocated to power. No actual allocation of costs has been made, but the allocation to power will include the cost of the power plant and part of the cost of the dam and reservoir. The power system under the adopted plan will pay a large portion of the costs allocated to irrigation.

Altus Project, Oklahoma

THE project near Altus, Okla., will henceforth be termed the "Altus project" instead of the "Lugert-Altus project."

Water Supply, Vale Project

AT the end of April storage in the Agency Valley Reservoir was 60,000 acre-feet, and in the Warm Springs Reservoir 190,000 acre-feet. The Warm Springs Reservoir filled April 13. There will be sufficient water both for the Vale Oregon district and the Warm Spring district, with a hold-over in the Warm Springs Reservoir of 120,000 acre-feet, and in the Agency Valley Reservoir of 30,000 acre-feet at the end of the 1940 irrigation season.

Antispeculation Law Succeeding on the Owyhee Project

ALTHOUGH minor difficulties continue to require attention and gradual correction, the antispeculation provisions incorporated in the Owyhee construction repayment contract are working out successfully.

Railroad grant land companies originally held large tracts of land on the Owyhee project. Excess holdings were sold at appraised prices without question, enabling settlers to start developing their farms and building their homes without undue burden.

With nonexcess land sales, however, compliance with the law was harder to obtain. The only real method of enforcing compliance was to deny water to the land until requirements of the contract were met. Two fine tracts were kept dry for 2 years before an agreement could be reached. In general, however, landholders have been complying with the antispeculation provisions.

The antispeculation provisions in the Owyhee project repayment contract were prompted by experience. On the Arrowrock division of the Boise project, raw sagebrush land unprotected by antispeculation provisions sold as high as $75 to $100 an acre, and improved land as high as $300 an acre, before any construction payment was made.

As a result the settler who bought the land found himself saddled frequently with an interest payment that overshadowed his water charges, taxes, and other expenses.

It was recognized that if the settler was to be expected to meet his charges for water, and to succeed in his new farming venture, he would have to be protected from his own optimism. Before construction work started on the Owyhee project the owners of the land within the development had to agree by recordable contract to a Government appraisal of their holdings on the basis of dry-land values. With certain limitations, they had to accept this appraisal as a selling price.

The repayment contract for the Owyhee project provides that land in excess of 160 irrigable acres in a single ownership must be sold at appraised prices. It also provides that nonexcess land sold for more than the appraisal price must pay half the difference to the irrigation district as an advance payment against future construction, operation, and maintenance charges against the tract.

Original Government appraisal of project land is made without consideration of improvements such as clearing, leveling, seeding, and building and fence construction. Later the owner of the land is entitled to a reappraisal which includes the value of his improvements, plus twice the amount of past excess payments to the district, and all construction charges that have been paid.

Original appraisals are made part of the project repayment contract and are recorded in the county records. Reappraisals are also recorded as notice to buyers.

Construction Progress at Deer Creek Dam

PROVO RIVER PROJECT, UTAH

By JOHN A. BEEMER, *Resident Engineer*

THE PROVO RIVER project provides for the storage and delivery of a supplemental water supply for 100,000 acres of farm lands in the Utah and Salt Lake Valleys, and also provides additional municipal and domestic water for the cities and communities adjoining the irrigated areas. The project comprises the Deer Creek, Utah Lake, and Aqueduct divisions, and is the largest of the reclamation projects in Utah.

Good progress was made on the construction at Deer Creek Dam during 1939. The diversion and outlet tunnel had been excavated and concrete-lined, the excavation and structure work for the relocated railroad was about 70 percent completed, and rough excavation for the highways was completed except through the North Deer Creek borrow pit; also such work in the dam foundation as could be done prior to river diversion, mainly about 65 percent of the stripping, had been accomplished. The contractor's gross earnings had amounted to 23 percent of the contract price of $2,189,096.50, and the elapsed time was 12.4 percent of the 1,350 days total contract time.

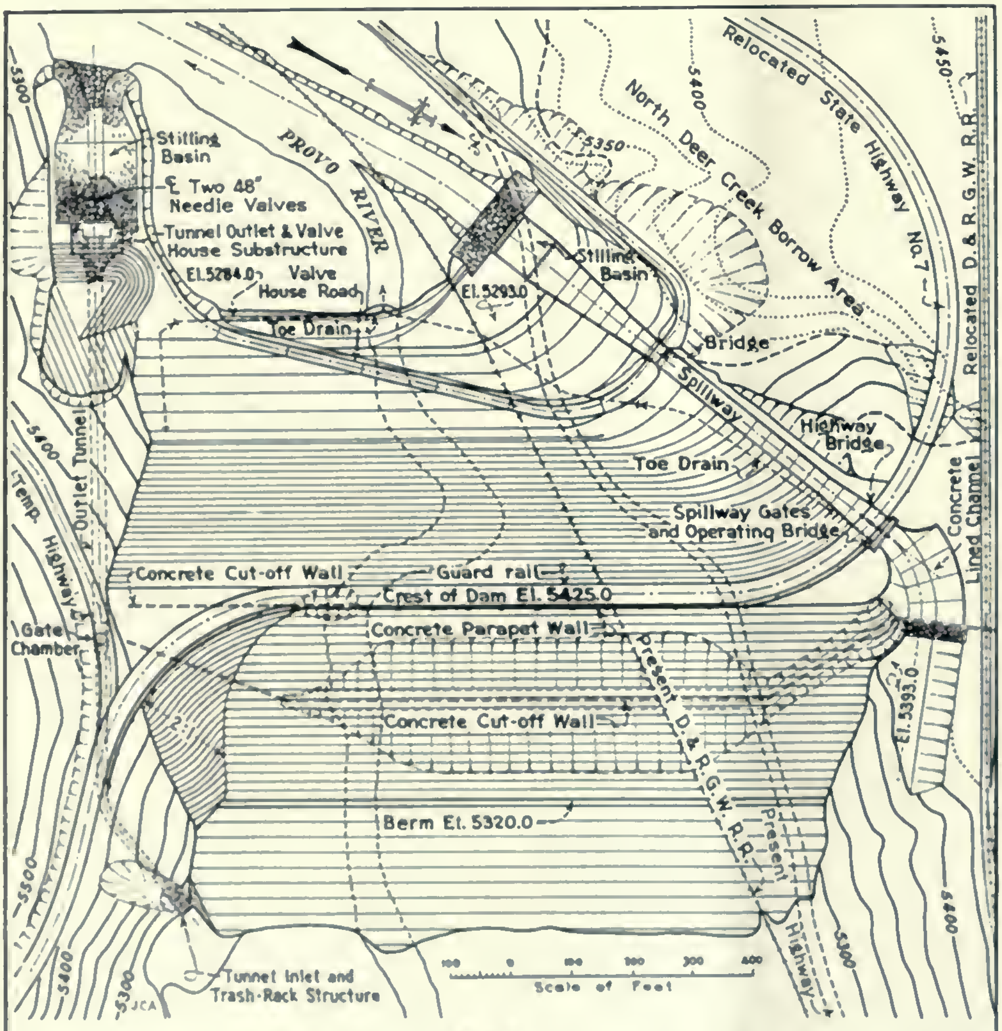


Figure 1
GENERAL PLAN DEER CREEK DAM

Construction program.—The contractor's program for 1939 covered the following principal features of construction:

(1) Completion of the diversion and outlet works as required to permit river diversion.

(2) Completion of the temporary highway and the portion of the main highway to the left of the dam for traffic diversion.

(3) Completion of the dam foundation work in the river bottom, involving excavation of the cut-off trench under the dam embankment, construction of the concrete cut-off wall and grout curtain across the rock foundation, and backfilling the trench with selected borrow-pit materials.

(4) Completion of the relocated railroad to the extent required for traffic diversion.

The outlook at the beginning of the season for completion of this program was anything but encouraging. The foregoing features, except the highway construction, were interdependent. Failure to get all of the work done in the deep cut-off trench and the trench backfilled before stopping of embankment work by cold weather would leave the foundation subject to damage. Little of the remaining foundation work could be done until after diversion of the river. Diversion of the river before the end of the spring floods would leave the old railroad immediately upstream from the dam subject to flooding. The materials for backfilling the cut-off trench, about 200,000 cubic yards to be taken from the railroad cut through the North Deer Creek borrow pit, would have to be placed before embankment work was stopped; otherwise, to complete the railroad work would necessitate stock-piling these materials.

The program, however, was successfully carried out by the contractor with increased forces and equipment by working three shifts almost continuously. Favorable weather and low water in the Provo River also contributed very greatly to the completion of the program. The river was diverted earlier than an average normal run-off would have permitted. The long Indian summer permitted late fall placing of embankment materials taken from the railroad cut and favored the track laying, ballasting, and other operations. At the end of the year the contractor suspended construction operations on account of low temperatures and snow. The works were left in good condition for the winter and for resuming construction work in the spring.

Contractor's progress.—At the end of 1939 the total contract earnings amounted to

$1,037,130.18, or 47.43 percent of the total contract price of $2,189,096.50, and the elapsed time was 533 days, or 39.48 percent of the total of 1,350 days' contract time.

During 1938 the construction in the dam foundation was necessarily confined to such work as could be done prior to river diversion. However, by making changes in the river channel and unwatering portions of the foundation, the contractor was enabled to complete a large part of the stripping, amounting to 130,000 cubic yards. Also, in the larger area to the left of the river channel, he constructed the downstream toe drains, excavated a portion of the main cut-off trench to a shallow depth (about 22,000 cubic yards), and constructed small portions of the gravel and rock fills in the downstream toe of the dam with suitable materials from the outlet works and foundation excavations.

Construction in main cut-off trench.—On June 1, 1939, immediately after diverson of the river, excavation of the main cut-off trench was resumed. Two Northwest draglines of 2½- and 1½-yard capacity and a fleet of 5-yard Koehring Dumptor trucks were used for the excavation and hauling.

The trench was unwatered by pumping from a sump in the left end. To begin with, the amount of water pumped from the sump was about 2 second-feet. The contractor also kept a pump in operation just above the waste piles, about 500 feet upstream from the dam, and another at the upstream toe of the dam, to intercept seepage into the upstream side of the cut-off trench excavation. These two pumps discharged about 4 second-feet of surface drainage into the river diversion channel above the tunnel intake.

The materials excavated were mainly sand, gravel, and cobbles except for a nearly continuous sandy-clay layer, 4 to 10 feet thick, lying 10 to 15 feet below the stripped surface. The side slopes of the excavation stood well and there was no evidence of the piping of fines from the foundation into the trench. Excavation during June amounted to about 33,000 cubic yards.

The suitable excavated materials were placed directly in the gravel and rock-fill downstream sections of the dam or were stockpiled. The unsuitable materials were wasted upstream from the dam.

During July 1939 the excavation work progressed rapidly, the contractor having added to his equipment a 2½-yard Link Belt dragline and a fleet of 7-yard Mack trucks. Two 12-yard carry-all scrapers drawn by RD8-Caterpillar tractors were also used in the low reaches of the trench. Excavation for the month amounted to 87,000 cubic yards.

The unwatering was continued by pumping from sumps as the excavation was deepened toward the central part of the trench. The average inflow increased to about 3 second-feet. Two Union Iron Works 8-inch centrifugal pumps powered by 100-horsepower motors, mounted on steel barges, were operated intermittently to keep the water level below the main excavation work.

The side slopes of the trench continued stable even in places where considerable seepage water issued from the sides. The water table on each side of the trench was gradually lowered, so that by the end of July the inflow was nearly all coming in near the trench bottom and along the rock foundation. The materials near the bottom were mainly coarse and not subject to sloughing.

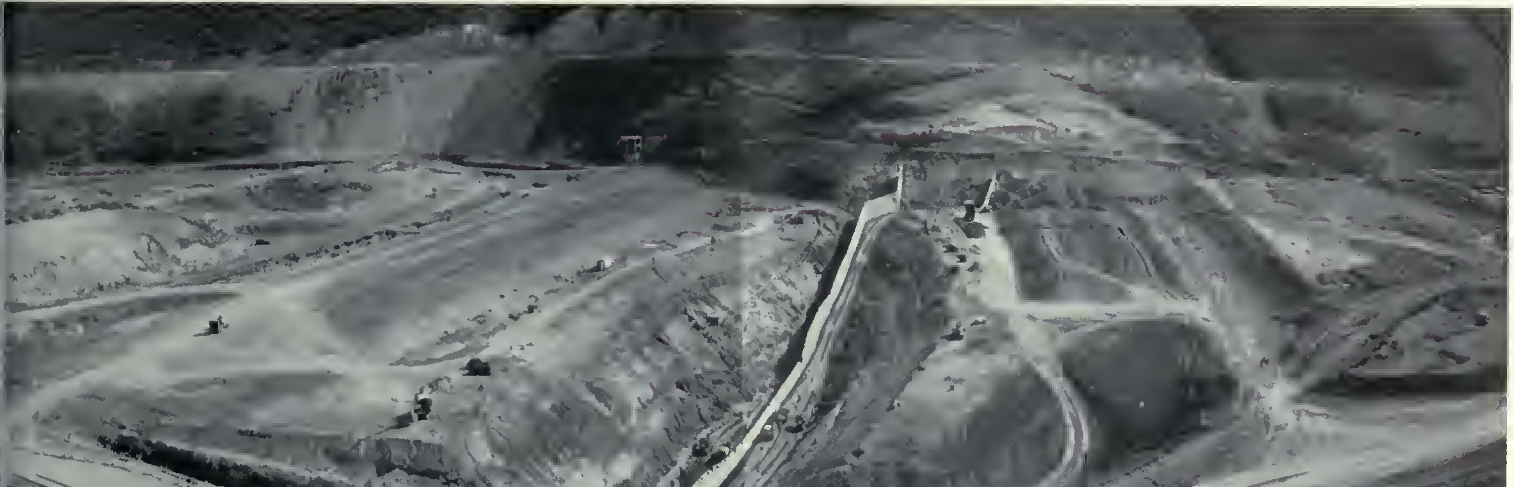
During the period July 17 to 27, the contractor made a belated attempt to drive well points in the slopes for installing a well-point system for unwatering in accordance with the method proposed in the specifications. It was found that this method of unwatering would be impracticable for this particular job on account of the large content of coarse gravel and cobbles in the material. At the contractor's written request, therefore, he was permitted to continue the same method of unwatering used up to this time, together with an adequate system of drains in the bottom and slopes of the trench to be well grouted after backfilling the trench.

As the trench narrowed and the excavation reached the rock bottom, the amount of equipment used and the yardage output were considerably reduced. The rough excavation was followed by cleaning the rock surface, constructing drains, excavating the footing for the cut-off wall, concreting the wall footing and drilling and grouting of the foundation rock. The final rough excavation in the deep portion of the trench was done mainly with a 2½-yard Northwest dragline loading into two 12-yard carry-all scrapers drawn by RD8-Caterpillar tractors. These tractor-carry-all units, helped by a tractor booster, were used to make the steep slippery climb out of the trench after truck haul was abandoned.

In September the "clean-up" excavation was completed across the rock bottom with light equipment and hand labor. The material was hoisted out of the trench in rock skips attached to dragline derricks and delivered to trucks for disposal. Construction of drains in the cut-off wall footing, drilling and grouting, and other follow-up work was well under way by the end of the month. The river-bottom portion of the main cut-off trench excavation amounted to slightly more than 160,000 cubic yards. The completed trench section had a bottom width of 30 feet, 1¼ to 1 side slopes, and a maximum depth of 85 feet.

The amount of water pumped from the trench bottom averaged about 6 second-feet, the maximum about 6.5 second-feet. Measurements were made by means of a Venturi flume installed at the outlet end of the pump discharge line. An automatic recorder was used to obtain a continuous record during September and October, the period of maximum discharge.

Panorama No. 1. Status of Construction October 26, 1939



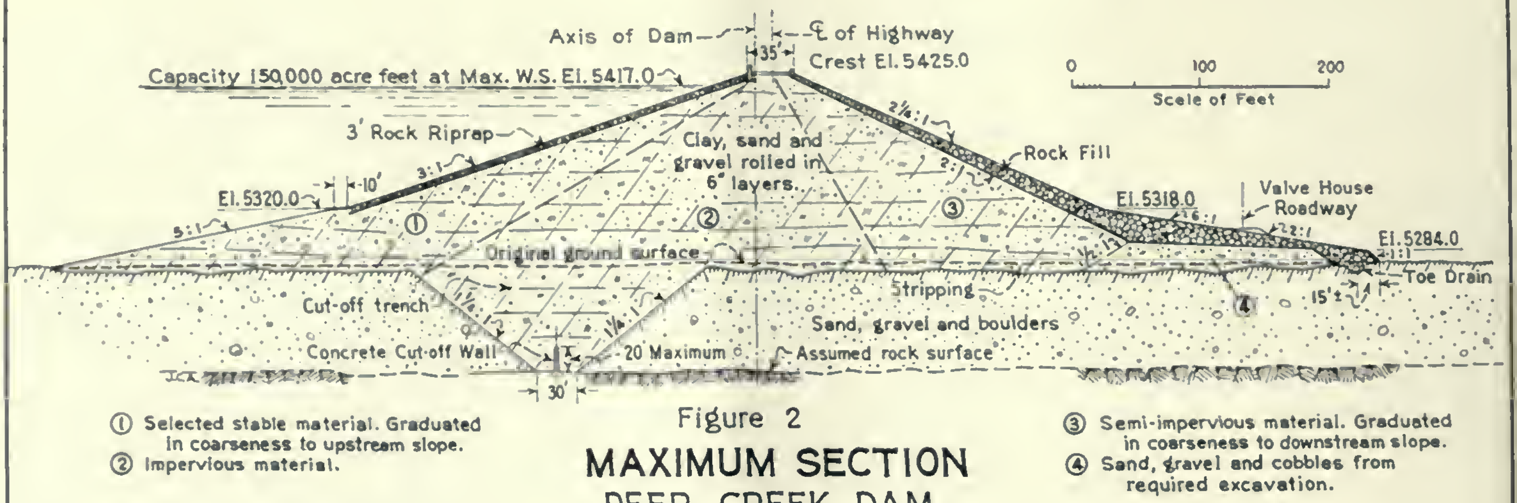

Axis of Dam
℄ of Highway
35'
Crest El. 5425.0
Capacity 150,000 acre feet at Max. W.S. El. 5417.0
0
100
200
Scale of Feet
3' Rock Riprap
Clay, sand and gravel rolled in 6" layers.
2½:1
Rock Fill
3:1
El. 5320.0
10'
2:1
El. 5318.0
Valve House Roadway
5:1
①
②
③
6:1
2:1
El. 5284.0
Original ground surface
2:1
Toe Drain
Stripping
Cut-off trench
Sand, gravel and boulders
④
15'±
Concrete Cut-off Wall
20 Maximum
Assumed rock surface
30'
① Selected stable material. Graduated in coarseness to upstream slope.
② Impervious material.
③ Semi-impervious material. Graduated in coarseness to downstream slope.
④ Sand, gravel and cobbles from required excavation.

Figure 2
MAXIMUM SECTION
DEER CREEK DAM

The final drainage provisions consisted of constructing a covered concrete sump at the lowest place in the trench bottom, from which all the drainage was pumped, and a system of drains in the foundation and lower slopes of the trench leading to the sump. The cut-off wall footing formed the downstream side of the sump through which an opening 2½ feet below the top of the sump was left to take the drainage from the downstream side of the cut-off wall. Openings in other sides of the sump, about 1 foot below its top, admitted drainage from the upstream side. The openings were screened with punched boiler plate placed on the outside of the sump walls. Perforated metal pipes of 4- to 12-inch diameter were laid in trenches in the rock foundation along the toe of each slope and covered with cobbles and gravel, with connecting spur drains of 2-inch minimum diameter where needed. Riser pipes of 2- to 4-inch diameter were welded to the side-drain pipes and extended up the slopes of the trench for use in grouting the drains after backfilling the trench. Where the seepage was continuous over portions of the side slopes, rock and gravel blankets were placed beginning at the drains and extending far enough up the slopes to "dry up" the wet areas.

Pumping equipment used for unwatering from the concrete sump consisted of two 8-inch Jaeger vacuum pumps with 40-horsepower motors and two 8-inch Union Iron Works centrifugal pumps with 100-horsepower motors. The two Jaeger pumps delivered into an outlet line where one of the centrifugal pumps was used as a booster. The other centrifugal pump served as a standby unit for operation when each of the Jaeger pumps was moved, in turn, up the slope during backfilling of the trench. This system proved very satisfactory and at no time was the backfill damaged or the placing stopped on account of pump trouble.

On October 19 backfilling of the trench was started, all other construction in the river bottom portion of the trench, including the drainage system, the concrete cut-off wall and grout curtain having been completed. Panorama No. 1, taken October 26, 1939, shows the status of construction at that time. Selected materials of low percolation rate, from the railroad cut through the North Deer Creek borrow pit, were used for the backfill. The usual methods of placing, compacting, and testing were used in accordance with the specifications for placing earth fill. Very little difficulty was experienced from wetting of the fill on the trench bottom and slopes as the drains and pumps operated very satisfactorily throughout the backfilling work. The trench was practically filled by November 29 when the earth fill work was discontinued for the winter. The surface of the fill was graded to provide a drainage leading to an automatic pump to prevent the accumulation of surface water and to facilitate preparations for resuming the earth fill work in the spring. The appearance of the embankment on December 1, 1939, is shown by Panorama No. 2.

Other foundation work.—Nearly all the remaining construction work in the river bottom portion of the dam foundation was completed during the year at intermittent periods when it did not interfere with the progress in the main cut-off trench. Foundation stripping between the dam abutments was completed except for a small area occupied by the old railroad along the base of the right abutment.

The lower portion of the secondary cut-off on the left abutment was completed, including the trench excavation, wall construction, grouting, and backfilling with embankment materials.

Test borings revealed the presence of clay deposits in the river bottom portion of the dam foundation downstream from the axis, extending from both abutments toward the center of the foundation. These deposits, 4 to 9 feet thick, underlie the surface gravel of the stripped foundation at depths of 14 to 18 feet. To break the continuity of these clay deposits a trench, 50 feet wide at the bottom and about 400 feet long, was excavated across the foundation parallel to and 140 feet downstream from the axis of the dam. The depth of the trench was determined by the bottom limits of the clay deposits, averaging about 22 feet. Suitable gravelly materials from the excavation were placed in the gravel-fill section of the dam and the clay was discarded. The trench was backfilled with compacted materials, suitable for this portion of the dam.

Grouting

The design of the dam provides for construction of a grout curtain in the rock foundation under the main concrete cut-off wall extending the full length of the structure to prevent the passage of water through rock seams under the dam and through the abutments. It was decided to extend this grout cut-off into the rock surrounding the outlet tunnel under the left dam abutment to intercept seepage just above the gate chamber.

Grouting in the outlet tunnel.—The drilling and grouting for the portion of the curtain about the tunnel was started April 20 and completed May 20, 1939. The work was done inside the tunnel, after the concrete lining had been finished, by drilling and grouting two rings of holes at tunnel stations 9+50 and 9+70. Each ring contained 6 holes equally spaced in the tunnel circumference but staggered with those in the other ring. The holes were 25 feet deep about the bottom and left side of the tunnel and up to 100 feet deep above and to the right. The fans of holes pointing upward were directed so as to intersect the grout curtain to be constructed later under the main concrete cut-off wall on the left abutment.

Standard air-powered equipment was used for the drilling, grout mixing, and pumping, the set-up and operation of which met specification requirements and gave satisfactory results. The drilling was mostly in limestone with some sandstone and shale. The strike of the formation is nearly at right angles with the tunnel and the dip is approximately 25° upstream.

Cement and water grout was used. The average mix was 1 part cement to 3 parts water. The holes of greater depth than 25 feet were grouted in two stages at about 30 and 100 pounds pressure respectively. The grout taken by the first shallow holes seemed to go mainly around the concrete lining, and, as indicated by the grouting which followed, made a tight seal between the concrete and rock. Some of the deeper holes intersected seams in which the grout was forced down the dip to the tunnel lining upstream. The largest take was 349 cubic feet in a second-stage grouting, during which operations, grout appeared at a construction joint in the tunnel lining 100 feet upstream. The two rings of holes took a total of 607 cubic feet (sacks of cement), 437 in the first ring grouted and 170 in the other.

From observation of this grouting it is believed that a good seal was effected along the tunnel lining and in the adjacent rock.

Grouting in the main cut-off trench.—Drilling and grouting work in the main cut-off trench was started at the left abutment of the dam on August 3 and closely followed the trench excavation and preparatory work in the rock bottom across the dam foundation. Grouting was completed through the 800-feet distance between abutments by October 18 just prior to backfilling the trench. The work was frequently interrupted and complicated by the unwatering operations and the congestion due to rapid prosecution of other construction in the trench.

The cut-off wall footing was placed in a water-bearing limestone and it was necessary to construct cobble and gravel drains in the footing trench to handle the inflow of water during concreting operations. The drains were then thoroughly closed and grouted prior to any curtain grouting under the cut-off wall footing. This was a difficult process due to leaks developing at the sides of the footing. In extreme cases sawdust and small pieces of burlap were added to the grout mixture to seal the leaks until the following cement and water grout had set. This preliminary special grouting was very successful, and in the subsequent curtain grouting few bad leaks developed.

The general procedure of the curtain grouting resulted in a spacing of holes up to 50 feet in depth at 10 feet, up to 75 feet in depth at 20 feet, and up to 100 feet in depth at 40 feet. However, where observations of the drilling or grouting gave doubt of good results, deeper drilling or closer spacing of shallow holes was used. The procedure gave evidence of the effectiveness of the grouting as the first and second intermediate holes usually took successively less quantities of grout. Where this was not true the probable need of additional grouting was indicated.

The drains under the footing were grouted with a 1.0 to 0.7 cubic foot water to 1 cubic foot cement mix at maximum pressures of 20 to 25 pounds per square inch. The 20-foot stage was then grouted with a minimum mix of 3.0 at a maximum pressure of 25 pounds, and the 50-foot stage with a minimum mix of 5.0 at pressures of 50 to 60 pounds. The third stage was then grouted at about 100-pound pressure. Where holes took grout rapidly the mix was gradually thickened but not to less than 1.0 except in cases of bad leaks. Where satisfactory holding pressures could not be obtained due to leaks which could not be calked, subsequent grouting was done through the same or additional holes until it appeared that the grouting was complete.

The total drilling in the 800-foot portion of the main cut-off trench completed between abutments during the 1939 season amounted to 6,612 linear feet and the grouting amounted to 12,435 cubic feet (sacks of cement) of which 772 cubic feet were used in special grouting of drains and springs in the cut-off wall footing trench. The largest "take" was 1,628 cubic feet in the third stage of a 100-foot hole near the middle of the foundation.

Parker Contract Awarded

ON May 9, the Chicago Bridge & Iron Co. of Chicago submitted the successful bid of $184,500 for furnishing and erecting 4 steel penstock pipes of welded plate steel, 22 feet in diameter for the Parker power plant at Parker Dam on the Colorado River, 15 miles northeast of Earp, Calif. With a water capacity of 5,000 cubic feet per second, these penstocks will convey the river water from the forebay at the left end of the dam down to the turbines in the power plant. The hydraulic units will operate under a head of about 72 feet.

All of the penstocks will be installed in the tunnels with the exception of the downstream make-up piece of each penstock, which will be erected by the Bureau of Reclamation.

The Parker Dam power plant will consist of four main units, each with a capacity of 30,000 kilowatts. Machinery is already on order for three of the main units, comprising the initial installation.

Panorama No. 2. Appearance of embankment December 1, 1939

Irrigation History and Resettlement of Milk River Project, Montana

By GLADYS R. COSTELLO, *Malta, Mont.*

(Continued from May issue)

AGAIN in July a crew was sent in from the ranch to put up the hay. Temporary fences were strung around the stacks and in ordinary winters some of the "she stuff" was trailed in for the season. A man or two "batched" at the single-room log cabin on the place and fed the cattle during cold weather. In extremely hard winters some ranchers hauled the hay from the valley for cattle on the range while others moved their stock in for the winter.

On the surface the construction of a costly irrigation system for the use of a limited number of cattle and sheep owners might appear unjustified. That this was not the case was due to the fact that these stockmen, during the early construction period of the irrigation system, had unlimited free range for their stock and could afford the higher priced land for raising winter feed and, during the period following completion of the system, construction charges were not immediately fixed. With the growing conviction among all classes of people that "dry land" farming was a failure, the land was held in many instances as a speculation.

Dry Farming Found Unprofitable

That dry farming northern Montana's semiarid prairies, except for the few districts where better soils provided a basis for large scale wheat farming, was impossible was becoming more firmly established each season. Farm relief in the form of seed, feed, summer fallow, and subsistence loans in the counties of Phillips, Blaine, and Valley up to 1930 had reached an estimated $5,000,000 and during the next 4 years was to mount $3,000,000 higher. Hundreds of farmers had already abandoned their farms. Cultivated fields were overgrown with weeds. Delinquent taxes pyramided year after year. These astounding figures had piled up against this one comparatively small portion of the "dry farming" area of the State, despite the fact that a bumper wheat crop had been harvested in 1927 and a fair crop raised in 1928 had been sold at a comparatively high price level.

The early thirties were to experience even worse times. A 10-year drought faced northern Montana. Cultivated fields were to become miniature deserts. Dust storms were to black out the entire country. The native grasses were to be literally blown out of the shallow soil, only the cactus was to increase and spread a carpet of blossom over the barren hillsides in Junes to come.

Tribute by Pioneers to Dr. Elwood Mead

But northern Montana was fortunate in having a group of men with foresight and vision, one of whom was Henry L. Lantz who came to Phillips County in 1923 as county extension agent. Lantz received his bachelor's degree in agriculture from Montana State College in 1921 and in 1921–22 took graduate work in rural economics, specializing in resettlement, at the University of California under the professorship of the late Dr. Elwood Mead, pioneer land-use economist, who, on leaving the University of California, served as United States Commissioner of Reclamation from 1924 to 1936.

In this group also was H. H. Johnson, who came to the Milk River project in 1925 as superintendent, and was said to have been the first agricultural-minded superintendent assigned to the project. He had gained a keen insight into Dr. Mead's working theories, having worked directly under his supervision.

Josef Sklower, George Chambers, and Fred L. Robinson, all businessmen and landowners in the Malta district, together with Mr. Lantz and Mr. Johnson, made up a special chamber of commerce committee appointed to work out some agricultural program for the area.

Coming to Phillips County when he did, Mr. Lantz as county extension agent became familiar with the dry land farm psychology and the next year the philosophy of the country. Grounded in the fundamentals of land economics Lantz soon saw that, with most of the county definitely submarginal in character, those areas should be devoted exclusively to the livestock industry, while the irrigable lands and areas of better soil where large-scale wheat farming might be successful on a mechanized scale should be developed and made available to the farmers. One of his first achievements was the application of a soil map prepared by the Bureau of Soils and the Montana State Experiment Station as the basis for the development of an agricultural program for the county.

In commenting on that map, Mr. Lantz said at the time, "This soil study reveals that Phillips County with its immense acreage has everything from badlands in name and truth to the most excellent agricultural land. With so large a territory divided among such a sparse population, the most productive land should be utilized first and the poorer types of soil abandoned as far as farming is concerned. We have heard a great deal about eliminating the scrub cow and the boarder hen, but since the soil map has revealed the county as it is, we surely ought to eliminate the scrub acres from cultivation."

The soil map was released in 1925 and became the basis of a new philosophy among thinking farmers and far-seeing agricultural leaders. But there were to be drought years, low farm prices, insect pests, debts, and the reduction of the entire area to that of a "problem area" before the majority of the farmers abandoned their rosy dreams of easy money in dry land wheat farming for a hard-headed acceptance of the facts of soil and climate.

With such leadership as represented by the five men above mentioned, it was but a step to the formation of the "Malta Plan" of resettling dry land farmers in the irrigable valley. Mr. Lantz has always believed credit for the plan should have gone to Dr. Mead, through whose enthusiastic endorsement it became nationally known and was to appear later as part of the resettlement administration program.

Lack of local finances was the handicap and it was not until the drought year of 1933 that T. C. Spaulding, director of relief for Montana, notified the local resettlement committee that M. L. Wilson, then chief of the subsistence division of the Federal relief administration, was interested in conducting an experiment into the possibilities of establishing destitute dry-land farmers on irrigated lands in the Milk River Valley.

The following spring, Mr. Wilson called Mr. Lantz to Washington for a discussion of the local situation. As a result of this conference a program of retiring submarginal land from production was undertaken in this section of the State and when, in 1935, the Resettlement Administration was created, Mr. Lantz was named manager of the Milk River-northern Montana project, the largest in area in the United States.

Submarginal Land Retired

The program was twofold, retirement of submarginal land from future attempts at farming and the resettlement of the displaced population in the Milk River Valley. Public domain was withdrawn from homesteading and the era of the "free home in the West" was definitely of the past.

After five years' work, during which time the Resettlement Administration became the parent of the Farm Security Administration which was to take over the resettlement of destitute farmers, and the Soil Conservation Service which was to assume control of dry land purchase and development, the entire agricultural pattern of an area three times the size of the State of Connecticut had been changed.

The interdependence of these two programs, so completely recognized as to be included in one program under the old resettlement administration, is the unique factor of the Milk River-northern Montana projects, and upon their continued indivisibility rests the success of the venture.

To understand the importance of the combined programs one has but to remember that the greater part of the three project counties is submarginal range land and that practically every foot of farming land in this great expanse of country lies in the valley of the Milk River and its tributaries or in a few scattered communities where soil and large-scale farming practices make wheat farming practicable. The Milk River Valley bisects the project and, irrigated by the Milk River irrigation system, contains thousands of acres of rich and as yet undeveloped irrigable land, enough land to resettle all the unsuccessful dry-land farmers within the area and leave room for more.

(*Concluded in August issue*)

NOTES FOR CONTRACTORS

Specification No.	Project	Bids opened	Work or material	Low bidder		Bid	Terms	Contract awarded
				Name	Address			
		1940						*1940*
1334-D	Central Valley, Calif.	Mar. 11	Low-heat cement in bulk (1,650,000 barrels).	Calaveras Cement Co.	San Francisco, Calif.	$720,000.00	800,000 barrels, f. o. b. Kentucky House.	May 7
				Pacific Portland Cement Co.	do	412,500.00	412,500 barrels, f. o. b. Redwood Harbor; discount $0.10 per barrel.	Do.
				Yosemite Portland Cement Corporation.	do	444,544.80	437,500 barrels, f. o. b. Merced.	Do.
1337-D	Colorado-Big Thompson, Colo.	Mar. 18	Furnishing and installing 2-pipe, steam-heating system for headquarters garage.	(1)				
1343-D	Boulder Canyon, Ariz.-Nev.	Apr. 4	Gasoline-engine-powered motor boat.	Robinson Marine Construction Co., Inc.	Benton Harbor, Mich.	14,176.35	F. o. b. Boulder City	Apr. 26
1348-D	Provo River, Utah	Apr. 16	Two 21- by 20-foot radial gates and two 25,000-pound capacity motor-driven, radial gate hoists for spillway at Deer Creek Dam.	Lincoln Steel Works	Lincoln, Nebr.	[2] 3,575.00	F. o. b. Deer Creek Siding; discount ½ percent.	Apr. 29
				Valley Iron Works	Yakima, Wash.	[3] 2,700.00	F. o. b. Yakima; discount 5 percent.	Apr. 30
1349-D	do	Apr. 17	Two 52-inch tube valves for outlet works at Deer Creek Dam.	F. R. Galbreath d/b/a King Machine & Manufacturing Co.	Los Angeles, Calif.	12,493.00	F. o. b. Los Angeles	May 1
1353-D	Pine River, Colo.	Apr. 22	Three 37- by 19-foot automatic radial gates for Vallecito Dam.	Philips & Davies, Inc.	Kenton, Ohio	22,000.00	F. o. b. Ignacio	May 3
898	Parker Dam Power, Calif.-Ariz.	Apr. 15	Furnishing and erecting steel penstocks for the Parker power plant.	Chicago Bridge & Iron Co.	Chicago, Ill.	184,500.00	F. o. b. Washington Heights, Ill.	May 4
903	Central Valley, Calif.	Apr. 25	Eight 110-inch and two 91-inch welded plate-steel outlet pipes with semisteel bellmouths for Friant Dam.	Western Pipe and Steel Co. of Calif.	Los Angeles, Calif.	[2] 78,895.00	F. o. b. Los Angeles	
				Hardie-Tynes Manufacturing Co.	Birmingham, Ala.	[3] 6,840.00	F. o. b. Birmingham	May 1
907	Columbia Basin, Wash.	Apr. 18	Heating and seat plate assemblies for spillway ledge heating equipment for drum gates at Grand Coulee Dam.	Schmitt Steel Co.	Portland, Oreg.	42,984.00	F. o. b. Portland; discount ½ percent.	Do.
905	do	Apr. 22	Three 15- by 29.65-foot penstock coaster gates with hydraulic hoists for Grand Coulee Dam.	American Bridge Co.	Denver, Colo.	[2] 113,128.00	F. o. b. Gary, Ind.	May 9
				Consolidated Steel Corporation, Ltd.	Los Angeles, Calif.	[3] 82,000.00	F. o. b. Los Angeles	Do.
1354-D	Parker Dam, Calif.-Ariz.	Apr. 29	One 65.5- by 58.25-foot floating bulkhead gate for spillway at Parker Dam.	American Bridge Co.	Denver, Colo.	34,615.00	F. o. b. Gary, Ind.	Do.
B-38, 232-A	Columbia Basin, Wash.	Apr. 18	Steel reinforcement bars (2,535,000 pounds).	Bethlehem Steel Co.	San Francisco, Calif.	54,030.50	F. o. b. Odair; discount ½ percent on $0.47 less than bid prices.	Do.
B-46, 196-A	Colorado-Big Thompson, Colo.	Apr. 15	Steel reinforcement bars (641,000 pounds).	Colorado Fuel & Iron Corporation.	Denver, Colo.	17,659.30	F. o. b. Kremmling; discount ½ percent.	Do.
1352-D	Minidoka, Idaho	Apr. 18	One 35-ton, motor-operated, overhead traveling crane.	The Euclid Crane & Hoist Co.	Euclid, Ohio	10,026.00	F. o. b. Acequia, Idaho	May 10
904	Columbia Basin, Wash.	Apr. 24	Construction of a hatchery building at Entiat station.	West Coast Construction Co.	Seattle, Wash.	33,328.00		May 13
908	do	Apr. 29	Construction of a hatchery building at Winthrop station.	C. F. Davidson Co.	Tacoma, Wash.	44,357.00		May 14
B-22, 327-A	Kendrick, Wyo.	Apr. 26	Poles and crossarms	L. D. McFarland Co.	Sandpoint, Idaho	[4] 21,002.50	F. o. b. Sandpoint	Do.
B-38, 176-B	Columbia Basin, Wash.	Apr. 22	Station wagons, sedans, trucks	Steuart Motor Co.	Washington, D. C.	[2] 12,369.37	F. o. b. Detroit. Discount 10 percent.	May 16
				A. L. Collins Motor Co.	Grand Coulee, Wash.	[5] 3,505.67	F. o. b. Dearborn	Do.
				General Motors Corporation.	Detroit, Mich.	[6] 11,757.83	F. o. b. Coulee and Leavenworth. Discount 5 percent.	Do.
				Day Majer Co.	Spokane, Wash.	[7] 1,813.02	F. o. b. Leavenworth	Do.
32, 801-A	Tucumcari, N. M.	Apr. 24	Steel reinforcement bars (1,709,028 pounds).	Carnegie-Illinois Steel Corporation.	Denver, Colo.	45,005.55	F. o. b. Newkirk, N. M. Discount ½ percent.	May 22
B-22, 328-A	Kendrick, Wyo.	May 1	Insulators (13,000)	Joslyn Mfg. & Supply Co.	Chicago, Ill.	19,240.00	F. o. b. Casper, Wyo. Discount 2 percent. Shipping point Lima, N. Y.	Do.
1355-D	All-American Canal, Ariz.-Calif.	May 13	Self-contained air cooler and distribution system for project office at Brawley, Calif.	C. G. Hokanson Co.	Los Angeles, Calif.	1,155.00	F. o. b. Los Angeles. Discount 2 percent.	May 20

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[1] All bids rejected.
[2] Item 1.
[3] Item 2.
[4] Schedule 1.
[5] Items 2, 3, and 4.
[6] Items 5, 10, and 12.
[7] Item 11.

Land Classification

Columbia Basin Project, Washington

By W. W. JOHNSTON, *Reclamation Economist*

THE classification of land on the Columbia Basin project has been in progress since the summer of 1937; and at the close of 1939, 1,051,737 acres, or 55.7 percent of the total estimated acreage to be covered by this type of survey, had been classified. This figure represents both arable and nonarable land.[1] The work has been done with a maximum of four field parties, that number being able to classify the land as rapidly as the topographic surveyors produced the topographic maps which served as base maps for the classifiers.

The suitability of land for irrigation farming is dependent on soil and topographic conditions, and both soils and topography vary widely in different parts of the project. The area is all underlaid at greater or less depth by basalt of the Columbia Basin lavas, bared in places by the erosive action of water during the periods when glaciers dammed the Columbia River and glacial waters flowed over and then inundated at least the larger part of the project. Deposition from the same source covered vast areas, giving rise to the Ringold formation, a stratified deposit made up of loosely consolidated sandstones and sandy shales with a limestone member. This limestone, basalt, unconsolidated gravels, and coarse sands constitute the underlying materials which, in places, are near enough to the surface to affect the utility of the soils for irrigation farming.

Soil Types

While minor variations are numerous, the soils of the project may be divided into six types for consideration as potential irrigable lands. The largest acreage of really high class soil has developed from loessal materials, wind deposits of silty materials derived in part from volcanic ash, but probably more largely from the outwash deposits of the Ringold formation. These loessal soils extend, in a strip from 4 to 12 miles in width, along the eastern border of the project, and in a small body on the slopes of Babcock ridge, situated a few miles west of the town of Quincy. These soils vary from fine sandy loam to silt loam in texture, and are uniformly deep and highly fertile, being represented in the Wheeler and Ritzville soil series, as mapped by the United States Bureau of Soils and the State experiment station. The principal limiting factor in this type of land is topography, for while the surface is generally only gently rolling and desirable for irrigation farming, some of the slopes are excessive.

Deep alluvial soils, derived largely from the loess and included in the Sagemoor and Warden soil series, occur in the immediate vicinity of Quincy, at the higher elevations of the Wahluke slope (south slope of Saddle Mountains), and elsewhere in limited areas of the project. These soils occupy gentle slopes having even surface relief, and are of equal fertility with the loessal soils. Their texture is in most cases silt loam, and the soils are deep, free from rocks, and of excellent character for irrigation, although they may be somewhat difficult to drain if seepage develops.

Soils of the Burke and Koehler soil series, underlaid by limestone, occur in the Frenchman Hills area extending northward past the old settlement of Burke, in a relatively narrow strip lying below the loessal soils between Wheeler and Connell, and in two bodies of considerable size located near the Columbia River, in the southwestern part of the project. This soil has developed where limestone of various thickness, and apparently a part of the Ringold formation, has neither been buried deeply by sediments nor removed by erosion. The soil depth above this nearly impenetrable stratum varies from a few inches to several feet, and its value for irrigation farming is correspondingly variable. The principal concern with the shallow and moderately shallow soils of this character is that irrigation may develop seepage which will be difficult to remedy by artificial drainage, because of insufficient depth. The land classification standards have been fixed to eliminate the dangerously shallow soils from the arable classes.

Soils of the Ephrata soils series have been developed on sand, gravel, and boulders deposited by large volumes of rapidly moving water, which carried the fine materials farther on. The soil, which is of variable depth but generally less than 4 feet, is a brown sandy loam of high fertility, with excellent drainage. Except in stony areas, the principal limiting factor is the thinness of the soil layer, which, in places, is insufficient to prevent excessive percolation losses to the underlying porous strata under irrigation. An extensive phase of this general type, occurring between the mouth of the lower Grand Coulee and Moses Lake, contains a serious mixture of boulders and large cobbles in the plow zone. During the later diversions of the Columbia, the gigantic volumes of water discharging from the Coulee deposited enormous quantities of boulders and gravel in a fan covering several townships. Apparently through wind action, soil was deposited on the surface, to sift between the surface boulders and cobble. The major portion of this stony phase of the gravel subsoil land has been eliminated both from the arable area and from the different irrigation districts, because the cost of clearing rocks to permit cultivation would be prohibitive.

"Pot Holes"

The "Pot Holes" area, lying north of the eastern half of Frenchman Hills, occupies the deepest portion of the bed of old Lake Quincy which, according to geologists, once covered the portion of the project north of Saddle Mountains. Shifting sands cover the "Pot Holes" area, and many of the troughs between the sand dunes are filled with water. Other sand areas occur north of Pasco, in areas along the Columbia south of the Wahluke slope, and in less extensive areas elsewhere on the project. Except where sufficient fine material is mixed with the sand to give it reasonable fertility and waterholding capacity, these sands are eliminated from the areas proposed for irrigation.

In general, the soils of the project are on the light-textured side. Very little alkali is encountered, and the soils, free working, respond well to irrigation and modern farm practices. Variations in soil conditions, however, are numerous, and it has been found necessary to carry the land classification to considerable detail in order to obtain a reliable inventory of lands which are suitable for development under irrigation. The most important part of the land classification is the elimination of the unsuitable lands from the acreage which can be counted on to make good irrigation farms capable of supporting families and supplying revenue for the payment of irrigation assessments. The latter lands are further subdivided into three classes on the basis of value for irrigation farming, class 1 representing the best arable lands of the project, class 2 the intermediate or average lands, and class 3 the least desirable lands for which it is proposed to provide an irrigation supply.

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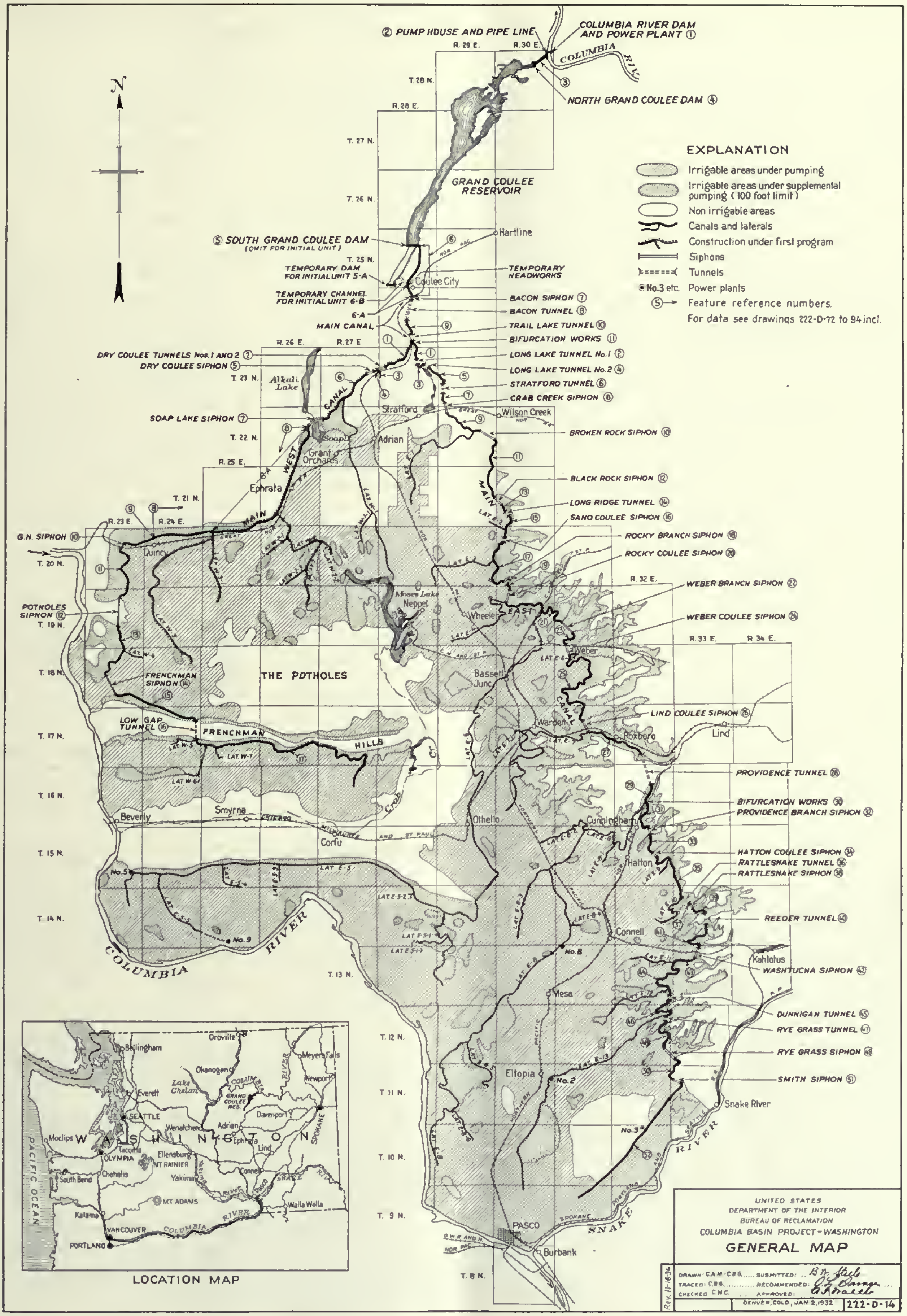
[1] The preliminary estimate, based on a reconnaissance land classification made in 1923, indicated a net project area of 1,200,000 acres of arable land susceptible of irrigation, which was selected from a gross acreage of nearly 2,500,000 acres.


② PUMP HOUSE AND PIPE LINE
COLUMBIA RIVER DAM AND POWER PLANT ①
NORTH GRAND COULEE DAM ④
GRAND COULEE RESERVOIR
⑤ SOUTH GRAND COULEE DAM (OMIT FOR INITIAL UNIT)
TEMPORARY DAM FOR INITIAL UNIT 5-A
TEMPORARY CHANNEL FOR INITIAL UNIT 6-B
TEMPORARY HEADWORKS
MAIN CANAL
BACON SIPHON ⑦
BACON TUNNEL ⑧
TRAIL LAKE TUNNEL ⑩
BIFURCATION WORKS ⑪
LONG LAKE TUNNEL No. 1 ②
LONG LAKE TUNNEL No. 2 ④
STRATFORD TUNNEL ⑥
CRAB CREEK SIPHON ⑧
DRY COULEE TUNNELS Nos. 1 AND 2 ②
DRY COULEE SIPHON ⑤
SOAP LAKE SIPHON ⑦
BROKEN ROCK SIPHON ⑩
BLACK ROCK SIPHON ⑫
LONG RIDGE TUNNEL ⑭
SAND COULEE SIPHON ⑯
ROCKY BRANCH SIPHON ⑱
ROCKY COULEE SIPHON ⑳
WEBER BRANCH SIPHON ㉒
WEBER COULEE SIPHON ㉔
G.N. SIPHON ⑩
POTHOLES SIPHON ⑫
FRENCHMAN SIPHON ⑭
LOW GAP TUNNEL ⑯
THE POTHOLES
FRENCHMAN HILLS
WEST CANAL
EAST CANAL
LIND COULEE SIPHON ㉖
PROVIDENCE TUNNEL ㉘
BIFURCATION WORKS ㉚
PROVIDENCE BRANCH SIPHON ㉜
HATTON COULEE SIPHON ㉞
RATTLESNAKE TUNNEL ㊱
RATTLESNAKE SIPHON ㊳
REEDER TUNNEL ㊵
WASHTUCNA SIPHON ㊷
DUNNIGAN TUNNEL ㊺
RYE GRASS TUNNEL ㊼
RYE GRASS SIPHON ㊾
SMITH SIPHON (51)
Hartline
Coulee City
Alkali Lake
Stratford
Wilson Creek
Soap L.
Adrian
Grant Orchards
Ephrata
Quincy
Moses Lake
Neppel
Wheeler
Weber
Bassett Junc.
Warden
Roxboro
Lind
Othello
Cunningham
Hatton
Beverly
Smyrna
Corfu
Connell
Kahlotus
Mesa
Eltopia
Snake River
PASCO
Burbank
No. 2
No. 3
No. 5
No. 8
No. 9
COLUMBIA RIVER
SNAKE RIVER
Crab Cr.
T. 28 N.
T. 27 N.
T. 26 N.
T. 25 N.
T. 23 N.
T. 22 N.
T. 21 N.
T. 20 N.
T. 19 N.
T. 18 N.
T. 17 N.
T. 16 N.
T. 15 N.
T. 14 N.
T. 13 N.
T. 12 N.
T. 11 N.
T. 10 N.
T. 9 N.
T. 8 N.
R. 23 E.
R. 24 E.
R. 25 E.
R. 26 E.
R. 27 E.
R. 28 E.
R. 29 E.
R. 30 E.
R. 32 E.
R. 33 E.
R. 34 E.
N
EXPLANATION
Irrigable areas under pumping
Irrigable areas under supplemental pumping (100 foot limit)
Non irrigable areas
Canals and laterals
Construction under first program
Siphons
Tunnels
No. 3 etc. Power plants
⑤ Feature reference numbers.
For data see drawings 222-D-72 to 94 incl.
LOCATION MAP
WASHINGTON
PACIFIC OCEAN
Bellingham
Oroville
Meyers Falls
Okanogan
Newport
Everett
Lake Chelan
GRAND COULEE RES.
Davenport
SEATTLE
Wenatchee
Adrian
Ephrata
Moclips
Tacoma
OLYMPIA
Lind
SPOKANE
Ellensburg
MT RAINIER
South Bend
Chehalis
Yakima
Connell
Pasco
MT ADAMS
Walla Walla
Kalama
VANCOUVER
PORTLAND
COLUMBIA RIVER
SNAKE RIVER
UNITED STATES
DEPARTMENT OF THE INTERIOR
BUREAU OF RECLAMATION
COLUMBIA BASIN PROJECT-WASHINGTON
GENERAL MAP
DRAWN: C.A.M.-C.B.G. SUBMITTED: B. W. Steele
TRACED: C.B.G. RECOMMENDED:
CHECKED: C.N.C. APPROVED:
DENVER, COLO., JAN. 2, 1932
222-D-14
Rev. 11-16-34

Experience has shown that it is necessary to establish certain physical specifications or standards for the different classes of lands, in order to insure uniformity and to properly divide the area into classes. These standards are based on experience gained in similar studies elsewhere, supplemented by specific studies of results obtained under irrigation on the projects in the general vicinity of the area under investigation, where soil and climatic characteristics are similar. For instance, in starting the classification of Columbia Basin project lands it was important to know to what extent the sandy soils of the area were suitable for irrigation development. This problem was studied on three nearby irrigation districts where sandy texture has been the principal limiting factor in the success of the area under irrigation. Soils were examined on farms which have been profitably farmed under irrigation for a long period of years, on others which have been less successful, and on farms which have gone out of cultivation after a few years' trial. The history of these farms was obtained from well-informed local people, the record of water use was obtained, and soil samples were taken for mechanical analyses. The information obtained, considered in the light of feasible limits in the amount of irrigation water that can be economically supplied, made it possible to fix the standards for the different classes, as far as soil texture was concerned, on the basis of demonstrated experience. The standards with respect to topography, stony lands, depth to rock or gravel, and other factors were determined in the same way, although it was necessary to consider irrigated lands in the Yakima and Kittitas Valleys, as well as projects immediately adjoining the Columbia River, in order to duplicate all of the principal soil and topographic conditions encountered on the Columbia Basin project.

The efficacy of the standards and methods tentatively adopted was tested after the field work had proceeded for a short time, by having the general scheme and methods of classification studied by a board of consultants, which included representatives of the soil department of the State experiment station and the United States Bureau of Soils, and a third member who has had long experience in the development and management of irrigated farms in the Yakima Valley. The suggestions made by this board were embodied in the standards finally adopted.

It has been found desirable to consider the suitability of land for irrigation farming under three headings: First, the soil in which texture, depth, structure, nature of underlying materials, alkalinity, and surface rock are considered. Topography is then considered, both as to the degree of slope and the nature of the surface, or the amount of leveling that would be required to put the land under irrigation. Drainage conditions are likewise considered, although this factor is not subject to as accurate determination as the others. Standards for class 1, for instance, are as follows:

Soil texture—fine sandy loam to friable clay loam; depth to gravel, sand, or cobble, 30 inches or more; depth to solid rock, either basalt or limestone, or to impervious caliche, 4 feet; depth to calcareous hardpan which is permeable following a period of irrigation, 18 inches if underlaid by permeable material extending to a depth of 4 feet.

Alkaline reaction—pH 9 or less, except that under certain conditions a higher reaction may be permissible in the subsoil with the total soluble salts generally 0.2 of 1 percent or less.

Rock—none in the plow zone of a size that will interfere with cultivation.

Topography—up to 5 percent slope if reasonably large-sized bodies slope in the same plane; surface smooth enough that leveling can be accomplished almost entirely with a float.

Drainage—soil and topographic conditions such that no specific drainage requirement is to be anticipated. The standards for classes 2 and 3 are correspondingly lower in all respects. Land may be placed in a lower class than "1" for deficiency in any of the items listed, and the reasons for the lower classification are indicated on the soil map by placing the letter "S" after the classification number if the deficiency is in soil, "T" if the deficiency is in topography, "R" if the lower classification is due to excessive rock in the plow zone, and "D" if the limiting factor is drainage.

Frequently, combinations of these conditions are involved. Areas for instance, indicated as being in class 2 with the letters "S" and "T" following the classification number, are deficient in both soil and topography, whereas land designated as "2S" will have class 1 topography but second-class soil. Areas classed as nonirrigable, and designated as class 6 on account of soil conditions include lands made up of coarse sandy soil having less than 15 percent silt and clay, areas regardless of texture which are less than 12 inches in depth to gravel, sand, or cobble, or 24 inches to solid rock or caliche; and areas in which the alkaline reaction is excessive as indicated by the reaction of pH 9 or more in the surface soil or over 0.6 percent total salt. Regardless of the high quality of the soil, lands with slopes in excess of 15 percent are eliminated, as are those where the surface is so rough that the cost of leveling would be prohibitive. Areas eliminated on account of drainage include narrow valleys which would obviously become water-logged and which contain insufficient acreage to pay the cost of drainage, and also areas which have no surface outlet, where the cost of providing artificial outlets would obviously be in excess of the benefit. There are also included in the nonarable classes certain small areas of good land lying within larger bodies of nonarable land, when these would obviously not make usable fields. Further elimination from the arable acreage may later be necessary where it proves infeasible to make water delivery, but this matter is not subject to final determination until the lateral system is planned.

Topographic maps made by engineering forces of the Bureau are used as base maps. These have a horizontal scale of 400 feet to the inch and a contour interval of 2 feet. It is unnecessary to actually survey the boundaries between the different classes of land because the change between one class and another is in most cases a gradation rather than an exact line, and it is possible for a competent man to sketch these boundaries with the aid of the topography and distances determined by pacing and reading a speedometer, with no greater error than that involved in determining just where the classification boundary should be.

The method followed in the field is to drive or walk along the one-sixteenth lines in the direction that most nearly crosses the changes in slope, deviating from that line as much as is necessary to carefully examine all of the area. Soil borings or pits are put down, where required, with a minimum of one hole for each one-sixteenth corner. The pits are dug to a depth of 5 feet except where rock or gravel is encountered, and occasional holes are extended to a greater depth where the classifier feels it important to explore the deeper subsoil. Careful notes are made on each profile and recorded in the spaces provided. Where texture is a limiting factor, soil samples in sufficient numbers to check the field judgment are brought to the laboratory for mechanical analysis. Samples are likewise analyzed in the laboratory to determine the total salts and the reaction. A regular field laboratory is maintained, and a technician is kept busy making analyses.

Since the land classification involves many matters of judgment as well as of fact, it is to be expected that errors will be made. However, the personnel engaged in this work is trained in soils and also experience in practical irrigation; and the standards have been worked out on the basis of demonstrated experience. The land-classification surveys in progress therefore should provide a reliable basis for the determination of irrigable acreage, the allocation of construction costs on the basis of benefits, and for general project planning. Immediate use is being made of the classification in the appraisal of the project land. An appraisal board, which follows the land classifiers, has available for its use the results of the land classification both in map form and in summaries of the areas in the different classes. The use of this material makes it possible to make a uniform and detailed appraisal at low cost.

Klamath 4–H Club Fair

THE county club agent, Clifford Jenkins, reported more committees functioning, more exhibits, and a larger attendance than ever before at the 4-H Club spring fair on the Klamath project.

Transplanting the Migratory Salmon and Steelhead of the Upper Columbia River

By STERLING B. HILL, *Associate Engineer*

DURING the year 1939, salmon and steelhead that normally pass the Rock Island Dam on their way to spawn in the tributaries of the upper Columbia River were intercepted at this dam and hauled to tributary streams between Rock Island Dam and Grand Coulee Dam. Eight tank trucks designed and built for this purpose were used. This is the first time that such numbers of adult salmon have been caught and hauled comparable distances, or placed in streams other than their natural habitat. The results of this operation are of special interest, in that similar transfers may be necessitated by the construction of other high dams across salmon streams of the Pacific slope.

Because of the difficulty of passing the adult upstream migrants over the 330-feet high Grand Coulee Dam, and the uncertainty that the small downstream migrants would survive a fall of this height or passage through the power turbines under the head involved, it was decided to transfer the runs to the Wenatchee, Entiat, Methow, and Okanogan Rivers. These streams have been nearly depleted of their salmon by the construction of dams with inadequate fish ladders, power plants, and numerous unscreened irrigation ditches that deposit the downstream migrants on the irrigated fields. It is believed that these streams will furnish sufficient spawning areas, and support the young of more salmon than now migrate to the Upper Columbia River above Rock Island Dam. One of the major reasons for this belief is the fact that the Columbia River drainage area above Grand Coulee Dam provides spawning grounds for less than 5 percent as many salmon per square mile as does the area below Bonneville Dam. The four tributaries between Rock Island and Grand Coulee Dams are much more comparable in spawning ground facilities to these lower tributaries than are the upper Columbia tributaries. They are known to have formerly supported large salmon runs, hence, if properly rehabilitated, they should accommodate a much larger number of fish than formerly spawned above Grand Coulee Dam.

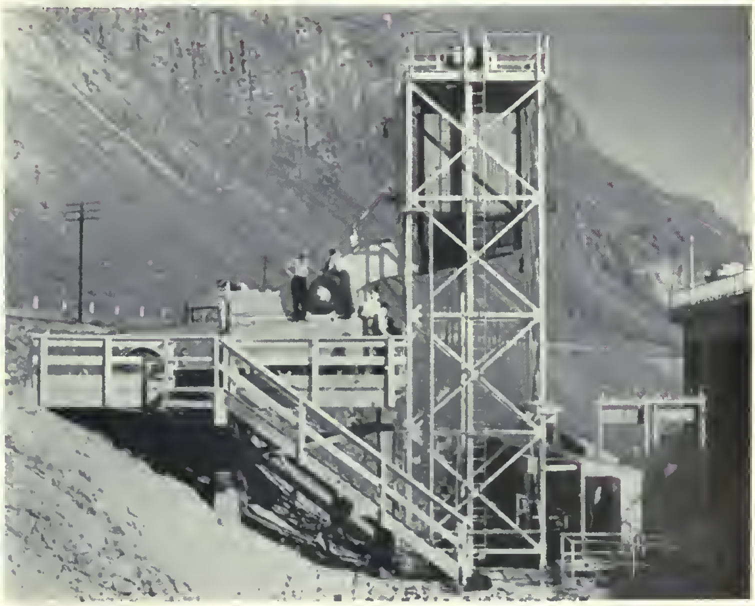
The program, as planned, involves the construction of traps and loading devices at the three fish ladders at Rock Island Dam; holding ponds on Icicle Creek, a tributary of the Wenatchee River; and hatcheries and rearing ponds on the four streams heretofore mentioned. The operation will be as follows: The fish will be trapped at the fish ladders at Rock Island Dam, loaded into tank trucks, and transported to the holding ponds on Icicle Creek, where they will be held from 1 to 6 months until they are ripe for spawning. They will then be caught and spawned artificially, and the eggs will be placed in troughs in the Leavenworth hatchery, which is near the holding ponds. The eggs will be held at this hatchery for a time, and then their respective quotas will be transferred to the other hatcheries. The eggs and "fry" will be in the hatchery from 3 to 5 months, depending on water temperatures, and when the fry are ready to feed they will be transferred to the rearing ponds. From the rearing ponds, the fish, after being fed for periods of 3 months to 1 year, will be hauled in the tank trucks and distributed to the various tributaries, where they will remain until they move downstream to the ocean.

In 1938, the fish passed through the low blocks in the Grand Coulee Dam over temporary fish ladders. In 1939 the construction of the dam had progressed to a height that made it impossible to pass the fish. The holding ponds and hatcheries were not ready for use, so it became necessary to haul the fish directly to the streams and allow them to spawn there in a natural manner.

Three varieties of fish migrate from the

Trucks loaded with salmon leaving Rock Island Dam for Columbia River and tributaries

Fish elevator at Rock Island Dam dumping a load of salmon into truck for delivery to Columbia River and tributaries



ocean to the upper Columbia River, namely: Chinook, blueback, and steelhead. The Chinook and blueback salmon spawn in the fall and end their life cycle. The steelhead is really an ocean-going trout that ascends the rivers to spawn in the spring, and unlike a salmon does not die after spawning. They may go back to the ocean and return again to spawn. Chinook salmon, in their upstream migration, pass Rock Island Dam from May to October, inclusive, but there are three peaks—the spring run in May, the summer run in late July and August, and the fall run in September and October. The Chinook of the spring run are only about half the size (about 12 pounds average) of those of the summer and fall runs. Many of the latter weigh more than 30 pounds. The spring run spawns early in September and the summer and fall runs during October.

There is but a single run of blueback, starting about the middle of July and extending through August. The blueback ascend only the streams on which there are lakes suitable for rearing the young fish, which stay in the lakes until the spring of their second year when they migrate to the ocean, to return when 4 years old. The blueback is a small fish weighing about 3 pounds, but the meat is the finest and brings the highest price per pound.

There are a spring and a fall run of steelhead. The spring run spawns soon after arrival, but the fall run stays in the streams over winter and spawns the following spring. They average about 8 pounds in weight. The steelhead is a game fish, and many are caught by the sport fisherman, but there is also a good commercial catch in the lower Columbia River.

These migratory fish have a strong homing instinct that brings them back to the same stream—even to the same branch or creek in which they spent their young life. Numerous tests have shown that this homing instinct holds even with fish hatched from eggs from another stream than the one in which the young fish were planted. For this reason, it is believed that the tribes of fish that in the past have spawned above Grand Coulee Dam can be successfully transferred to the four streams mentioned.

In preparation for the 1939 program of fish hauling, the permanent trapping and loading facilities at Rock Island Dam were completed, and eight 1,000-gallon tank trucks were provided. Unloading ramps and downstream racks were constructed on the streams. These racks are necessary to prevent the fish from returning to the Columbia River, and attempting to proceed to their former spawning grounds above the Grand Coulee Dam.

Traps

In or contiguous to each of the three fish ladders at Rock Island Dam, double holding areas were constructed. On the downstream side are V-trap entrances from the fish ladders, through which the fish can move upstream into the area but not return downstream. The upper areas are 20 feet square, with 5 to 6 feet water depth. The water is diffused into the area through a slat bottom. This bottom or "brail" is movable, being operated by electric hoists. At the side of the holding area is the trap bucket or tank, of 1,000-gallon capacity. Mounted on the edge of this tank is a picket fence which permits a flow of water across the tank, and prevents the fish from jumping out. Connecting the fenced area with the holding areas is a V-trap entrance, with counting board in the bottom. The V is closed with a picket gate that is raised to allow the fish to swim into the trap. There is a steel elevator tower over the trap, with the electrically operated elevator mounted on top. The roadway at two traps is more than 20 feet above the water level in the trap. The top of the trap tank sits about 2 feet below the water surface. Water, supplied to the trap well from the rear, flows through the pickets, over the tank, and out through the pickets of the trap entrance into the holding area.

Loading

When a load of fish has accumulated in the holding area, the operator telephones to the garage in Wenatchee for a fish truck. The truck is iced on the way to the trap. On arrival, the truck is backed up to the elevator tower, the loading hatch is rolled back, and the truck is half filled with water by an electrically operated pump. In the meantime the trap operator has opened the gate between the holding area and the trap and started the motors to raise the floor of the holding area. As this rises, it also tilts forward, crowding the fish toward the trap entrance. The operator counts the fish as they enter the trap tank, and when a proper load has passed, the gate is closed. The elevator is then started and the bucket of fish raised to the dumping level. The dumping chute is lowered, and the load of water and fish dumped into the truck by release of the swinging door in the end of the trap tank.

During the period of the blueback run, the trapping was complicated by the fact that it was necessary to separate the blueback from the Chinook and steelhead before loading, so they could be hauled to the two available lakes—Wenatchee and Osoyoos. The other fish were dumped in the streams. For purposes of segregation, a secondary holding

Truck used in transporting salmon

Ice is dumped into compartment of truck for purpose of cooling water in which salmon are placed

Hatchery Creek fish rack across the Wenatchee River above Tumwater Canyon, looking downstream

Fish transport truck at dumping site on Wenatchee River near Plain

area adjoining and below the regular area was provided. An additional picket gate was inserted in the trap entrances between the holding areas. The picket spacing was such that the small blueback could pass through, but the Chinook and steelhead could not. The blueback were loaded out, and then the special picket gate was raised, and the larger fish allowed to enter the loading area to be loaded into another truck.

Fish Trucks

Special tank trucks were designed and built for hauling the fish. They contain a 1,000-gallon tank with a 4- by 6-foot hatch in the top for loading, and a door in the rear for dumping. The hatch is opened and closed by turning a crank. In closing, the last turn of the crank turns the eccentric mounting of the rollers, and cinches the hatch cover on the rubber seat. The dumping door is hinged at the top. A single throw of a lever uncinches the door and allows it to fly open. A coil spring pulls the door wide open, and a catch holds it there until released for closing. The door closes on a rubber seat, and is leak tight.

An ice compartment that holds 1,200 pounds of broken ice is forward of the fish tank. Below and on either side of the ice compartment, separate gas engine-driven pumps of 125 gallons per minute capacity are mounted. Only one pump is operated at a time, the other being a standby. The water is drawn from the forward end of the fish tank near the top, whence it passes through coils in the ice compartment, and is diffused into the bottom of the fish tank. A constant supply of air is provided by a jet injector on the discharge pipe between the pump and the tank. A dial on the instrument board shows the driver the water temperature. The temperature can be regulated by the driver by means of a lever which controls the percentage of circulating water that passes through the coils in the ice compartment. Excess air escapes from the top of the tank through an arrangement that prevents the loss of water.

The truck chassis is carried on six wheels, the four rear wheels having double tires. The drive is on the forward rear axle. All wheels are equipped with air brakes. There are five gears, including an overdrive for 50 miles per hour speed.

Fish Hauling

Hauling adult fish from the Rock Island traps was started on May 1, 1939, and continued to December 9, 1939.

Nason Creek.—The first fish were hauled to Nason Creek, a tributary of the Wenatchee River which joins the river just below Lake Wenatchee, which is about 50 miles upstream from the Columbia River. The fish were dumped into the creek 6 and 10 miles above the downstream rack, which is near the mouth of the creek. As this rack was not completed until several days after hauling started, some fish escaped downstream and were later observed below Grand Coulee Dam.

A considerable number of fish drifted down to the rack but after staying a few days in the pool above and satisfying themselves that escape downstream was blocked, they moved upstream and distributed themselves along the 15 miles of good spawning area above. They lay in the deeper holes until spawning time, when they moved onto the gravel riffles, dug their nests, and deposited the eggs the same as they would have done on their native stream bed.

There were 3,913 Chinook and 1,353 Steelhead hauled to Nason Creek between May 1 and June 21, 1939. The average haul was 58 miles, requiring 6 hours for the round trip including time of icing, loading, and dumping.

The Steelhead started spawning about two to three weeks after arrival, and a few months later large numbers of young Steelhead were observed in the creek.

Entiat River.—The lower 15 miles of the Entiat River is a rapid flowing stream, with boulder-strewn bed which affords practically no good spawning area. In the next 15 miles above, the river has less grade and a good gravel bottom, and offers excellent spawning facilities. A downstream rack was placed across the river at the lower end of this area. Two dumping ramps were provided.

The average haul from Rock Island Dam to the Entiat River dumps was 53 miles, and required 7 hours for the round trip. Between June 22 and October 26, 1939, 2,830 Chinook and 2,355 steelhead (with 553 blueback that inadvertently got into the loads) were hauled to the Entiat River.

Wenatchee River.—Hauling to the Wenatchee River was commenced on July 18, and continued to the end of the season. There were 3,674 Chinook, 1,020 steelhead, and 984 blueback dumped into the Wenatchee River. The blueback run is practically over by the end of August. No attempt was made to segregate the stragglers after that date, but the loads containing blueback were mainly routed to the Wenatchee, with the hope that they would go on up into Wenatchee Lake. How many did so is not known, but 15 to 20 backed down to the rack and spawned just above it.

The downstream rack was placed across the river at the head of Tumwater canyon, about 35 miles above the mouth of the river. The fish were dumped into the river near the town of Plain, about 10 miles above the rack. The haul was 54 miles and the round trip required 7 hours' time.

Wenatchee Lake.—The placement in Wenatchee Lake consisted of 7,934 blueback, 595 Chinook, and 680 steelhead.

A temporary rack about 300 feet long was placed across the river just below Wenatchee Lake. The dump was about 3½ miles up the lake, on the north shore. Most of the blueback spawned in the two tributaries entering the head of the lake. A few spawned in the river just above the rack. The haul was 66 miles, and the round trip required 8 hours.

Osoyoos Lake.—Osoyoos Lake is about 8 miles in length, with the south 3½ miles in the United States and the rest in Canada. The fish dump was about one-half mile south of the international boundary. The distance by highway from Rock Island Dam is 155 miles, and the round trip, including reicing at Pateros, took 16 hours. A downstream rack was placed across the Okanogan River at the lake outlet. Provision for passing small boats had to be made in this rack.

There were 9,895 blueback, 135 Chinook, and 158 steelhead placed in Osoyoos Lake. It is believed that most of the blueback moved into the upper deeper portion of the lake to await their spawning time. Very few fish showed at the downstream rack. The fish were observed spawning in their normal way in the river above the lake, and in places along the shore of the lake.

Methow River.—No fish were hauled to the Methow River in 1939 because the numerous irrigation ditches, diverting water from this stream, had not yet been screened.

Except for about 10 miles of the Entiat River road and short turnouts to the dumping ramps, all the hauling was done over good surfaced highways.

Water Temperature Control

The salmon are affected by sudden changes of temperature, and will not survive in too high water temperatures. For this reason it is necessary to control the water temperature during transportation. As the major portion of the hauling was done during the summer months, considerable ice (506 tons) was required. The temperature of the water of the Columbia River was higher than that of the tributary streams, so that the water in the truck tank not only had to be kept from rising but was cooled several degrees in transit. In the long haul to Osoyoos Lake, the trucks were reiced at Pateros, which is about at the half way point. The Osoyoos Lake water, at the point of dumping, was at higher temperature than the Columbia River water and the temperature maintained during transit. On arrival at the dump, lake water was pumped into the truck to equalize the temperature before dumping.

During the spring and fall, 500 to 1,000 pounds of ice per load was used. During the hotter days of summer, the trucks going to the Wenatchee and Entiat Rivers were partially reiced in passing through Wenatchee after loading fish at the traps, the original 1,200 pounds capacity being insufficient for the trip. On the long haul to Osoyoos Lake about 2,000 pounds of ice per trip were used.

Losses

There was practically no loss in hauling steelhead, spring Chinook, or blueback. During the hottest weather in August, a few large Chinook died in transit. To avoid loss, it appeared to be necessary to limit the load to comparatively few of the large fish during this period. It is possible that the loss was due to injury before or in the loading process, rather than to conditions in transit.

It was originally intended to provide 2,000-gallon tanks on the trucks for the major portion of the hauling during the peak of the run, and 1,000-gallon tanks to be used in the slack periods. The elevator buckets at the traps were made with 1,000-gallon capacity, so the full bucket would be dumped into the half-filled truck. The elevator bucket is provided with ports so half the water can drain off while being elevated, so as to accommodate the 1,000-gallon trucks. However, only 1,000-gallon trucks were provided. This necessitated draining down the trap bucket, with the load of fish, to half full. Apparently the fear of being left stranded unduly excited the large fish. Also, dumping them from a height of 3 feet into 2 feet of water in a steel tank may have resulted in some injury. To correct such conditions, it is proposed to provide an overflow on the truck, and spillage facilities at the traps, so that a full elevator bucket can be dumped into a practically full truck tank.

Most of the losses were from loads of fish from the ladder in the middle of the river. Adjacent to this ladder is a section of the dam where the spillage flows over a ledge with projecting rocks. At times the fish spend several days in this area next to the ladder in vain attempts to get over the dam, before they will enter the ladder. Many fall back on projecting rocks and are injured, while others are more or less exhausted by their repeated attempts to get over the dam. It is proposed to remedy this condition by shutting off the flow over the dam at this point for the period that this condition prevails.

Losses After Hauling

The 1939 transportation season may be said, in general, to have been successful; and, in spite of local problems and difficulties which developed from time to time, it is believed that as many salmon spawned in the new localities to which they were hauled as would have spawned had they been able to proceed to their natural spawning grounds. The fish placed in Nason Creek, and in the Wenatchee, Entiat, and Okanogan Rivers were watched carefully through the spawning season; and although some mortality was noted, a very satisfactory percentage were observed to spawn naturally. Consequently, no material diminution in the cyclical run 4 years hence is anticipated.

All design and construction in connection with the fish-hauling program are being done by the United States Bureau of Reclamation, following in general the specifications and recommendations of the State of Washington Department of Fisheries. The fish hauling was done under the supervision of the United States Bureau of Fisheries. It is expected that this Bureau will also operate the hatcheries when they have been completed by the Bureau of Reclamation.

Milk River Superintendent Has Accident

H. H. JOHNSON, superintendent of the Milk River project, was confined to the hospital in Great Falls, Mont., from April 13 to 30, as the result of a broken knee. He has now returned to duty, but time will be required to effect a complete recovery.

Yakima Crops Excellent

WEATHER was very favorable for routine farming operations on the Yakima project, Washington, during April. In general all crops were in excellent condition at the close of the month, and there appeared to be a heavy set of most fruits. Early seedings and plantings of sugar beets were making rapid growth. Because of favorable weather, absence of killing frosts, and increased planting the past few years, the cutting of asparagus this year has greatly exceeded the volume of other years.

Yakima Water Supply Conditions

WEATHER at the reservoirs on the Yakima project, Washington, was favorable for the conservation of the water supply. Temperatures averaged below normal. Precipitation for April averaged 141.5 percent of normal, and for the period beginning September 1, 1939, 78.9 percent of normal, as compared with 85.2 percent of normal a year ago. At the end of the month 3 inches of snow was on the ground at Bumping Lake Reservoir. Storage on hand at the end of April was 1,015,920 acre-feet, the largest accumulation for this date in the history of the project, as compared with 955,020 acre-feet and 961,023 acre-feet on the same date in 1939 and 1938, respectively.

Origin of Names of Projects and Project Features in Reclamation Territory

THIS series of articles began with No. 1 in the March 1940 issue of the ERA, No. 2 appearing in the April issue, and with this issue we are continuing with No. 3, including the Humboldt, Truckee Storage, Uncompahgre, Yakima, Vale, Colorado River, Minidoka, Moon Lake, Provo River, Sanpete, and Umatilla projects.

Humboldt Project, Nevada

Humboldt.—This name comes from the famous German naturalist, scientist, and traveler, Alexander Von Humboldt (1769–1859), for whom Capt. John C. Fremont had deep admiration. Fremont made two expeditions into Nevada, the first in 1843–44, and the second in 1845–46. It is generally believed that on this second expedition, when Fremont and his party camped in the Ruby Mountains at the head of the Humboldt in 1845, he gave the river its name.

Rye Patch Dam.—This name was first given to a patch of wild rye grass and a small spring in the foothills 1 mile east of where Rye Patch Station, on the Southern Pacific Railroad, now stands. The name originated at the time of the trek of the Forty-niners across the Nevada desert, their trail following closely the present location of highway U S 40, which passes within a mile of the dam. The pioneers stopped at this patch of wild grass to rest their stock as there was good water and feed there. The dam was given its name because of its location, near to this historical spot.

Truckee Storage Project, Nevada

Truckee River.—One version of the origin of the name "Truckee" is that among the Paiute Indians living on the river was a bright young buck who picked up quite readily a few words of English from the white men coming through the country. Among the words he heard most frequently from the whites was "talk," to which the Indian added "ey." To his fellow tribesmen he became "Talkey," from which the name "Truckee" has been derived as the pronounciation by a Paiute even today sounds very much the same. The project took the name of the river.

Boca Dam.—This dam, located on the Little Truckee River, about one-fourth mile above its confluence with the Main Truckee River, derives its name from the town of Boca, Calif., which was located adjacent to and just below the present dam site. The town of Boca grew from the operations of the Union Ice Co. in storing and selling natural ice which was harvested from a pond created by a dam on the Little Truckee River, located about half way between the present Boca Dam and the mouth of the river. The works of the Union Ice Co. were abandoned some 15 years ago and the town of Boca, which at one time boasted a population of about 3,000 persons, has been torn down. "Boca" is the Spanish word meaning mouth.

Uncompahgre Project, Colorado

Uncompahgre.—The Uncompahgre River took its name from the Indian language, the word in the Ute dialect meaning hot water spring being derived as follows: *Unca*—hot; *pah*—water; *gre*—spring. Hot water springs constituted one of the serious difficulties encountered by the Bureau of Reclamation when constructing the Gunnison Tunnel to bring the waters of the Gunnison River to the Uncompahgre Valley.

The name of the project took the name of the river which was one of its principal sources of water supply.

Delta.—This town was named from its position near the delta of the Uncompahgre River at its confluence with the Gunnison.

Several canals of the project are the results of reconstruction of old ditches which were in use before the Government took over the project. Many of these, including the following, took their names from pioneer settlers of the valley:

Garnet, Ironstone, Loutzenhizer, and *Selig Canals.*

Ash Mesa, Franklin Mesa, and the town of *Olathe* are also said to have been named after early settlers.

Several features were named from their location with relation to the project or to towns of the project.

Gunnison River.—This is one of the principal sources of the water supply of the project. Water is diverted from the river through the Gunnison Tunnel to the Uncompahgre Valley. The name "Gunnison" commemorates Capt. John W. Gunnison, who in 1853 led a corps of topographical engineers of the United States War Department over what is now Cochetopa Pass in search of a feasible route for a railroad location. Captain Gunnison followed as long as possible the river which now bears his name, traveled thence through the open valley and across the Utah desert to the Sevier River where he was killed by Indians in October 1853.

Montrose.—This, the project headquarters town, was named at the suggestion of Joseph Selig, first mayor of Montrose, after the Duchess of Montrose, a character in one of Sir Walter Scott's novels. For several years the Rotary Club of the town exchanged Christmas presents with the Rotary Club of Montrose, Scotland.

Old Colorow Ditch and Shavano Valley.—Named after Ute chiefs.

Ouray and Chipeta ditches.—These two ditches were named after Chief Ouray, of the Ute Indians, and his wife Chipeta. Ouray was head chief of all the Ute Indians at the time the early settlers were entering the valley. Both Ouray and Chipeta were friendly to the whites and were well known by many of the early settlers. Ouray was instrumental in negotiating treaties with the Government. He died in 1880 and following his death the Uncompahgre Utes moved in 1881 to the Uinta Reservation in Utah. At the Chipeta Springs near Montrose is a monument to Chief Ouray and his wife Chipeta.

Taylor Park Dam and Reservoir.—Named after Edward T. Taylor of Glenwood Springs, Congressman for the western slope district of Colorado, who was instrumental in securing appropriations for the construction of the dam and who has always been regarded as a staunch supporter of irrigation projects.

Taylor River.—It is a coincidence that the name "Taylor" was appropriately applied to the dam and reservoir, and that the river on which the dam was constructed was named after James Taylor, an old prospector who first discovered gold in that section in 1860.

Vale Project, Oregon

Vale.—The city of Vale, the principal town in the area embraced by the project and the point at which the project office is located, derives its name from its topographical location in a valley, the dictionary definition of the word vale being "a valley." The name of the project follows that of the city.

Agency Valley Dam.—This dam is located on the North Fork of the Malheur River and is designated by the valley in which it is located. The valley received its name prior to 1874, when it became the site of an Indian agency. In July 1878 the 600 Indians at the agency rebelled against the Government, broke away from their reservation, and for the remainder of the summer engaged in hostilities on a wide front against the settlers of the region now comprising much of the Vale project. In the early fall they were defeated, captured, and transferred to other reservations. Although the Agency Valley was never again used as an Indian agency, it has retained the original name and naturally passed it on to the dam erected there by the Bureau of Reclamation.

Bully Creek west bench and Bully Creek east bench.—These two units lie adjacent to each other along the north bank of the Malheur River near Vale, and are separated by the course of Bully Creek, which contributes its name to both units. An interview with one of the oldest pioneers of this section has brought forth the following story on the naming of the creek:

Sometime in the years immediately following the Civil War, during a period of great activity in the Oregon gold fields, two prospectors undertook a long, dry journey into unfamiliar territory. Dusty, exhausted, and very thirsty, the men finally arrived on the bank of a stream. Taking a long drink of the cool water, one of them exclaimed: "That's bully!" And so the stream has been called "Bully Creek" ever since.

Willow Creek.—This unit lies in a narrow valley extending 25 miles northwest from Vale to Brogan, Oreg., and takes its name from the stream running throughout the valley's length. Clusters of willow trees line the banks of the creek and in its upper reaches spread out across the valley. The great number of these trees gives the creek its name. The route of the original Oregon trail closely follows the course of Willow Creek from Vale through the Willow Creek Valley.

Fairman Coulee Siphon.—This siphon is named in honor of J. D. Fairman, for many years a resident of Malheur County and one of its leaders in public affairs. Mr. Fairman worked unceasingly for the construction of the Vale project, and when it was discovered that one of the outstanding structures of the irrigation system crossed a coulee that had no name, his was chosen to designate it.

Harper and Little Valley.—Harper, Oreg., is a town lying approximately 23 miles southwest of Vale on the Ontario-Burns branch of the Union Pacific Railroad, in the center of an irrigated valley partially included in the Vale project. It came into existence in the early part of the present century when the railroad was being constructed west of Vale, and was given the surname of the first settler in that vicinity, a stockman named Harper.

Little Valley lies between Harper and Vale on the course of the Malheur River. Compared with the valleys lying immediately above and below it on the above-mentioned stream, it is small. Relatively and literally it is a little valley, naturally distinguished by such in early conversation, and hence so named.

Malheur.—The principal stream of the Vale project is the Malheur River, upon the North Fork of which is located the Agency Valley Dam. The legend of the naming of the river is as follows:

In the earliest days of the penetration of the Northwest by Caucasians a party of French trappers, camped upon the bank of a normally small stream since then known as the Malheur, was set upon by a war party of Indians. In escaping across the stream, at that time swollen by a spring flood, the trappers lost two men and a quantity of valuable furs. Thereupon they referred to the river as the Malheur, implying in their language a stream upon which they had experienced a bad hour.

Yakima Project, Washington[1]

Yakima.—This, the proper name of the project, valley, county, town, river, and Indian tribe and reservation, is an Indian word apparently having several meanings, such as "lake water," "black bear," "runaway people of the narrow river."

Ahtanum Creek, valley, range of hills, and town.—The name of these several features, Ahtanum, is an Indian word meaning "creek by the long mountain."

Benton County and town.—Named for Thomas H. Benton, United States Senator from Missouri.

Cle Elum Lake, storage dam and reservoir, town, and river.—The name of these features is an Indian word meaning "swift water."

Cowiche Creek and town.—The name Cowiche is the Indian word for "crossing on."

Easton.—This town was named because of its location, being near the east end of the Northern Pacific Railroad tunnel through the Cascade Mountains. The diversion dam for the Kittitas division followed the name of the town.

Grandview.—The impressive view from this site occasioned the name of the town.

Granger.—This town was named for Walter N. Granger, an engineer concerned in the early development of the Sunnyside division of the project.

Kachess Lake, storage dam and reservoir, river.—The Indian name Kachess means "many fish" or "more fish."

Keechelus Lake, storage dam and reservoir, river.—"Few fish" or "fewer fish" is the meaning of the Indian name Keechelus.

Kennewick.—This town has the Indian name meaning "grassy place."

Kiona.—The Indian name of this town means "brown hills."

Kittitas division, county, and town.—Kittitas is an Indian name meaning "shoal" or "shoal people"; also "white rock" and "land of bread."

Mabton.—Town named for Miss Mabel Baker, daughter of a Walla Walla pioneer.

Naches.—Town, river, valley, pass in the Cascade Mountains. This Indian name means "good or pure water."

Pomona.—The district, partially developed by artesian wells, was named for the Roman Goddess of fruit trees.

Prosser.—William F. Prosser, an early homesteader, was honored by having the town and power development on the Yakima River named for him.

Roza.—Division of the Yakima project and a station on the Northern Pacific Railroad obtained the name "Roza" in honor of the daughter of a railway official.

Satus.—The creek and division of the Wapato project were given the Indian name meaning "rich lands."

Selah.—A town with the Indian name signifying "still water" or "smooth water."

Snoqualmie.—A pass in the Cascade Mountains, also the town, river, and falls on the west side of the Cascades. Snoqualmie is an Indian name meaning "moon."

Sunnyside.—Town, division of the project, diversion dam, canal, and irrigation district, so named because the lands under the canal slope toward the midday sun.

Tieton.—Town, river, storage dam and reservoir, and division of the Yakima project—an Indian name meaning "little river" or "milky water."

Toppenish.—Town and Indian agency—an Indian word meaning "people of the trail coming from the foot of the hill"; also "meeting of the trails."

Wapato.—Town, irrigation project, diversion dam, and canal—an Indian name meaning "potato."

Wenas.—A creek and town with an Indian name meaning "last camping."

White Swan.—This town was named for an Indian chief.

Zillah.—The name of this town was given in honor of Miss Zillah Oakes, daughter of a Northern Pacific Railroad official.

Moon Lake, Provo River, and Sanpete Projects, Utah

The names of many physical features in Utah were given by Indian tribes.

Moon Lake project and dam.—The dam was constructed at the outlet of a natural lake which obtained its name from its crescent shape.

Provo River and city.—The river, which was formerly Timpanogo River, and the city derived the name from a hardy trapper, Etienne Provot (pronounced Provo), who was employed by the Rocky Mountain Fur Co. of St. Louis in 1882, and is believed to have been the first American to penetrate the inner Rocky Mountain region.

Sanpete County and project.—The name

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[1] The information here given has, for the most part, been taken from the book Origin of Washington Geographical Names, by Prof. Edmund S. Meany, leading authority on history of the Pacific Northwest, especially the State of Washington. Professor Meany (deceased) was a distinguished member of the faculty of the University of Washington.

Sanpete is a combination of the name of the Indian renegade, Chief San Pitch.

Deer Creek Dam.—Deer Creek was named by early settlers because of the large herds of deer which congregated along its course during winter to avoid the heavy snows covering the higher slopes of adjoining mountains.

Duchesne River, town, and county.—This name came from that of a Canadian trapper who was known to have gathered pelts and furs in the rugged Uintah Mountain area between 1830 and 1840.

Ephraim city and tunnel.—The town obtained its name from a Biblical character, and the tunnel carried the name because of its proximity to the city.

Great Salt Lake.—So-called because of its high degree of salinity (22 percent). The lake was discovered and in all probability named by Jim Bridger, the trapper, in 1824.

Jordan River.—The river, extending from its outlet to Great Salt Lake, was named Jordan because of the similarity between these two bodies of water and the Sea of Galilee and the Dead Sea. Jordan has been translated as The River of God.

Lake Bonneville. — The prehistoric Lake Bonneville derived its name from the explorer Bonneville, who is credited with having mapped the shore lines of this once vast body of fresh water which occupied a large portion of the Great Basin but has now diminished into two major lakes.

Uintah.—This name is derived from the "Yugwintats" tribe of Indians and "Yugwi," meaning "to sit."

Utah.—The name of the State comes from a tribe name of Indians spelled "Eutah," meaning "high up" or "in the tops of the mountains," also "land of the sun," because of the high Wasatch and Uintah Mountain ranges in the State.

Wasatch.—The meaning of Wasatch is "a low pass in a high range."

Umatilla Project, Oregon

McKay Creek and McKay Dam. — McKay Creek was named for Dr. William C. McKay, who was born in Astoria, Oreg., in 1824 and died in Pendleton in 1893. He settled near the mouth of McKay Creek in 1851–52. The dam followed the name of the creek.

Pendleton. — George Hunt Pendleton, of Ohio, who was Democratic candidate for President in 1864, was honored by the commissioners of Umatilla County who named this town after him.

Umatilla.—The Umatilla River was spelled in Lewis and Clark Journals in 1806 as "Yaumalolam." Umatilla or "Yumatila," is from the village name "I matilam," meaning "lots of rocks."

Colorado River Project, Texas

The Colorado River project takes its name from the river of the same name in Central Texas, the word "Colorado" being of Spanish derivation meaning blood red or ruddy.

Upper, Austin Dam; lower, Marshall Ford Dam, Colorado River Project, Texas

Austin Dam.—This is an old structure which is now being rehabilitated and has been renamed locally "Tom Miller Dam" after the present mayor of Austin. Stephen F. Austin, an American pioneer and founder of Texas, in December 1821 established the first permanent Anglo-American settlement at the site of the present city of Austin and capital of the State. His name has thus been perpetuated, the dam naturally taking the name of the city.

Buchanan Dam.—Named for the late Honorable James P. Buchanan, Member of Congress from Texas.

Inks Dam.—So named for Roy B. Inks, deceased member of the board of directors of the Lower Colorado River Authority.

Marble Falls Dam.—A small structure at the town of Marble Falls. The town and later the dam obtained the name from a small rapids in the river and the presence of a limestone formation in the locality which was erroneously supposed to be marble.

Clean Ditches Pay Dividends

By L. H. MITCHELL, *Irrigation Adviser*

IN many regions the loss of water in transit from the source of supply to the farm is appalling. During recent dry seasons, on one irrigation project with a water supply below normal, two-thirds of the water released from the reservoir was lost in transit. These water-conveyance losses are generally described as seepage and evaporation. A more comprehensive description would be seepage—losses by water percolation, evaporation—losses from the water surface and ground surface of the banks, and transpiration—the water given off by the plants growing on the banks of river, reservoir, canal, or equalizer. Here attention is especially directed to transpiration water losses, which are often overlooked.

That weeds and trees along water courses may consume and transpire considerable amounts of water is indicated by recent studies of the consumptive use of water. Research by the United States Bureau of Agricultural Engineering shows that tules and cattails under favorable conditions can use about 8 acre-feet of water per acre in one growing season. In experiments conducted at Davis, Calif., it was found that a single wild morning glory plant in a tank, took from the soil and gave off by transpiration 4 cubic feet of water in 144 days and that a prune tree, only 4 years old, used by transpiration 20 cubic feet of water in one season.

Climatic conditions, of course, play a part in the amount of moisture given off by transpiration. For example, the amount of water used by transpiration to produce a ton of alfalfa is not the same in Arizona as in Montana. And naturally a large tree would use much more water than a tree a few feet high.

Studies of canal water losses by one of the State experiment stations revealed that over a 10-year period the average water conveyance and delivery losses for all irrigation canals in the State increased 40 to 60 percent. During this period the new growths of trees along the water courses and the weed infestations on the banks undoubtedly increased considerably and it is safe to assume transpiration water losses contributed to this large increase in water losses.

Another striking example of water losses by transpiration was observed recently on an irrigation project. During the early period of project operation an irrigation canal about 15 miles long delivered ample water for the acreage it served. But from year to year the amount of water delivered to the farms decreased even though the same quantity of water was diverted from the river. Careful water measurements showed that there were excessive water losses through the reaches of the canal where large cottonwood trees were growing on the ditchbanks and at a considerable distance from the canal. After trees were removed, the original water supply was restored. It pays to have careful water measurements made to locate places of excessive water losses in a project irrigation system.

Water-loving weeds, willows, and other trees growing on the canal banks and in the water retard the flow of water and reduce the carrying capacity of the canal, often making it necessary to use the free board capacity of the canal and sometimes to push the water over the weeds. Weeds growing in the water consume and transpire far more water than is lost from the water surface by evaporation. View No. 1 shows a lateral with a heavy growth of cattails. Transpiration water losses in this lateral are high. View No. 2 shows the same lateral after cleaning. Note how cleaning has removed all of the water-wasting cattail.

In views 3 and 4 you see modern cleaning machines in operation, removing silt and weeds. This equipment leaves the canal with a smooth surface thus reducing the coefficiency of roughness.

Good management of an irrigation system requires keeping the banks of reservoirs, canals, and laterals free from useless plants, which consume valuable water and also may contribute to seepage water losses. Deep-rooted plants like sweetclover, wild morning glory, and willows not only pump water out of the moist soil, and indirectly from the canal, but also loosen the soil in the canal banks, thus increasing the seepage losses. And weeds along the banks of any water course drop their seeds into the water to find easy transportation to farm ditchbanks and fields.

What should be done to keep transpiration water losses along canals to a minimum? Except where trees are needed for shelter and windbreaks, banks should be cleared of willows, cottonwoods, weeds, and similar useless growth and their moist areas planted to shallow-rooted, hardy, weed-competing grasses.

Establishing aggressive weed-competing grasses on ditchbanks is not difficult but like planting seed in a field, there should be the proper seedbed and ample moisture. A seedbed, comprising a narrow strip about a foot wide just above the high watermark of the ditch, should be carefully prepared. The inside slopes of ditchbanks are kept moist by the side movement and capillary action of water from the canal. Often, too, the outside slopes and even the soil some distance from the canal may receive enough water to permit plants to grow. Generally the grass seed should be planted in early spring though in some localities late fall seeding will give the best results.

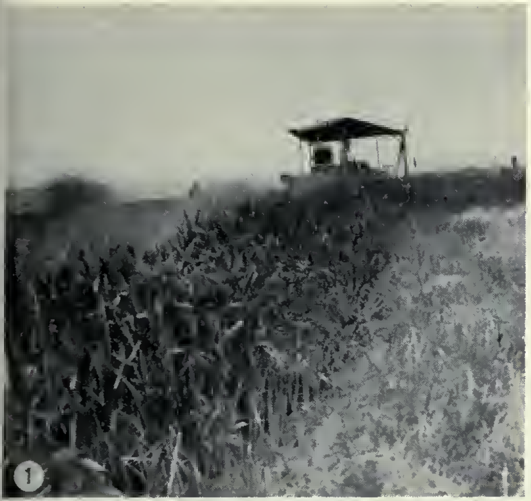
View 6 shows a small lateral with a good stand of young brome grass as it looked in the summer of 1939. These banks in 1938 had such a heavy growth of annual and perennial weeds one could scarcely see the water in the lateral. The weed growth was removed and a good seedbed prepared. Then late in the fall, when it was too cold for seed to germinate, the banks were seeded to brome grass. It is not necessary to seed the banks the entire length of the ditch. A good plan, especially if only a limited amount of seed is available, is to plant the upper ends of all ditches on a project. These small patches, with their roots creeping out to enlarge the area and with the maturing seed spreading by winds and water, in a few years will seed not only the right-of-way adjacent, but also considerable areas of ditchbank downstream.

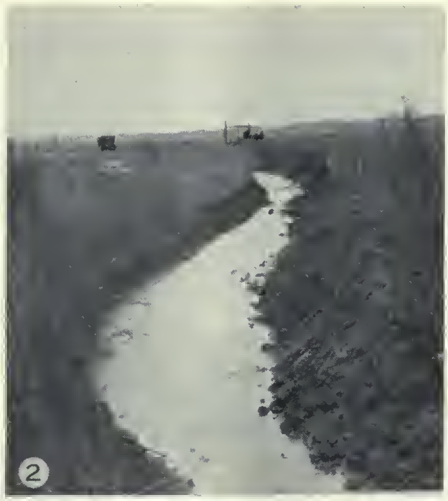
Such a self-seeded lateral is shown in No. 7. From one side of this right-of-way to the other, except for the area where water is run, there is a solid mat of brome grass. No part of this right-of-way was ever seeded to brome grass by man. But up the lateral a short distance a farmer had seeded his ditchbanks to brome grass. The seed from these upstream plants, traveling with the water, seeded the moist area of this ditchbank. Spreading from the water's edge over the top of the ditchbank, this sturdy grass now covers the entire right-of-way.

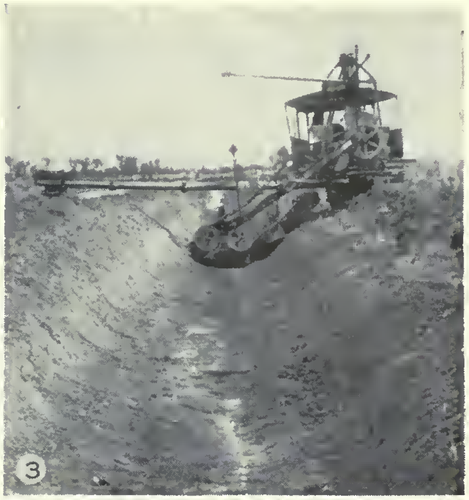
A well-established stand of brome grass on a ditchbank is not seriously injured by the material placed on the bank during cleaning operations. View No. 5 shows a ditchbank with a small ridge of bare soil thrown up by a ditch-cleaner. If brome grass will not take root on this newly placed soil neither will the weeds.

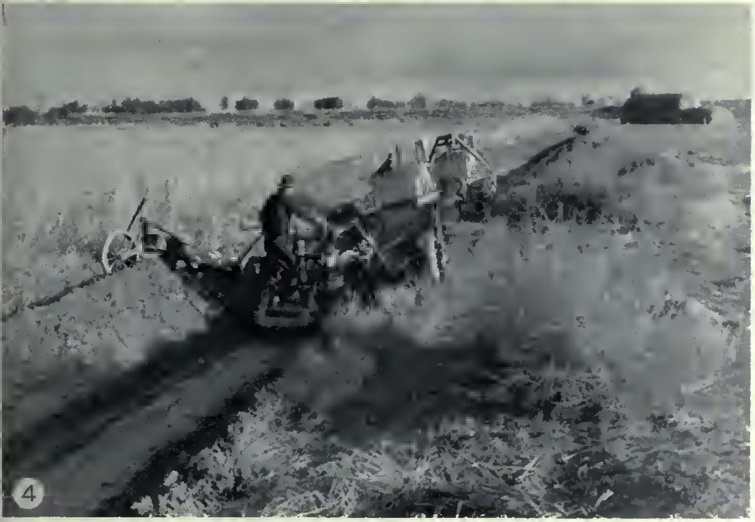
Brome grass and other aggressive grasses on rights-of-way serve dual purposes—control weeds and provide valuable supplemental pasture. Except on those projects where canal water is used for domestic purposes, the right-of-way should be fenced and used to pasture livestock. As the grasses are planted to keep out weeds, it is important not to allow overgrazing. Also, if the ditchbank material is such that it moves easily by trampling into the canal section, only sheep, calves, and other small livestock should be grazed on the ditchbank. And like the care of any other pasture, ditchbank pasture should be mowed at timely

(Continued on page 186)









No. 1 - Tules in a lateral before cleaning.

No. 2 - Same lateral as in No. 1 after cleaning.

No. 3 - A cleaning machine completing a round trip moving silt and plant growth.

No. 4 - Another machine that moves silt and weeds from both inside slopes of a canal in one operation.

No. 5 - Brome grass, a weed competitor, not seriously injured in cleaning canals.

No. 6 - A new growth of brome grass.

No. 7 - Brome grass on ditch banks serves dual purposes.

The Museum at Guernsey, Wyoming

IN a region rich in historical significance on the North Platte River in southwestern Wyoming, the Bureau of Reclamation completed the construction of Guernsey Dam in 1927. Impounded behind the dam, the millions of gallons of irrigation water are spread over an area of 2,300 acres in the timbered, gently rolling hills along the river. The formation of the reservoir created a natural park in an area remote from developed recreational facilities, and the residents of the adjacent sections of Wyoming and Nebraska were quick to appreciate the value of the lake to the community.

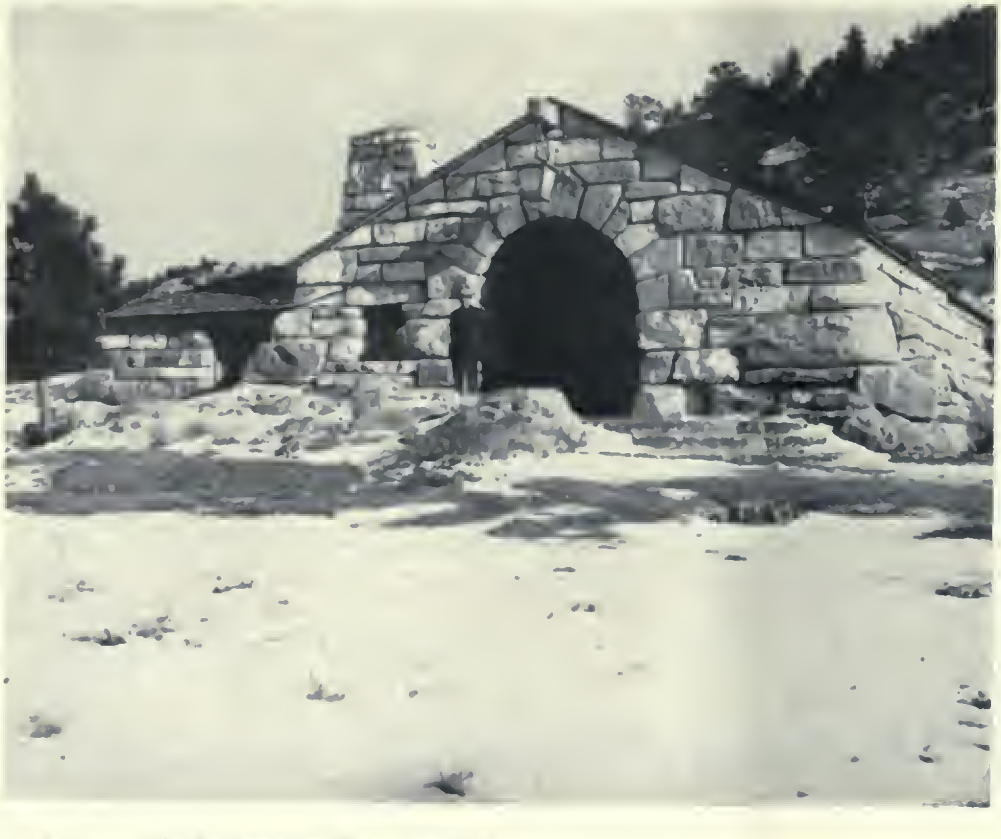
A painting in one of the exhibit cases. Early pioneers diverting water for irrigation

With the advent of the Civilian Conservation Corps, it became possible to develop the land along the lake shore with the necessary facilities to provide a park for public use. A CCC camp was established near Guernsey Dam in 1934 to build park roads, shelters, beach improvements, parking areas, trails, outdoor fireplaces, and picnic tables. The activities of the camp were supervised by the National Park Service to insure conformity with their standards of construction and to have available for consultation the experience and guidance of their officials skilled in development of national and state parks.

The prominent part the Guernsey area played in the early settling of the West led to a plan to include, as part of the Guernsey Park, a museum to envisage the interesting story of the Guernsey area.

A site was selected for the museum on the summit of a hill overlooking Guernsey Lake. The main entrance of the building was purposely laid out facing west, providing a fine view of Laramie Peak, 35 miles distant, to the visitor coming out of the museum.

West entrance to the museum at Guernsey Lake



The Museum Building

The building itself is one of the most beautiful small museums in the West. It is built of native sandstone of buff color, brought from a nearby quarry. Rocks with a natural weathered surface were carefully selected and laid to form the outside surface of the structure. The roof is framed of heavy hand-hewn timbers covered with 2-inch planks and split cedar shakes.

On entering the museum from the west entrance the visitor enters the first exhibition hall which is 45 feet in length and 24 feet in width. The second hall, at right angles to the first, is 35 feet in length and 20 feet in width. The walls of the exhibition halls are windowless, and artificial lighting is used exclusively. Fourteen exhibit cases, with plate-glass doors, have been built into the walls of the two halls. Each case has indirect lighting.

In each hall the floors are formed by natural flagstone floors laid over concrete. The flagstones selected for their smooth surface were brought from Thermopolis, Wyo., and were laid to a carefully planned irregular design.

In addition to the exhibition halls, the building contains a library room, a small office and a storeroom. The library has a fireplace and a floor of oak planking. A small basement contains a hot-air furnace with blower, air ducts and registers to heat the entire building. Water is furnished the building under pressure.

The interior of the building is stone throughout, with all woodwork a Florida "pecky" cypress, providing an effect rarely seen in museums of this type. The wrought-iron hardware door hinges, latches, lamps, chandeliers, light sconces, etc., were all máde by hand by CCC enrollees.

The Exhibit Plan and Story

The exhibit plan, the result of long systematic research, begins with the geologic history of the Guernsey area before the advent of man and proceeds to the present. The cover-all title of the museum story is How Man Has Attempted To Adapt Himself to the National Environment of the Guernsey Area From Prehistoric Times to the Present.

The story, told in 14 exhibit cases, begins millions of years ago with the geology of the area, showing successive changes of the terrain, including the formation of mineral deposits and the creation of Guernsey Canyon. Temperatures, rainfall, soil, plant and animal life, and their relationship to man are also covered. The first evidences of prehistoric man and their rock quarries are illustrated.

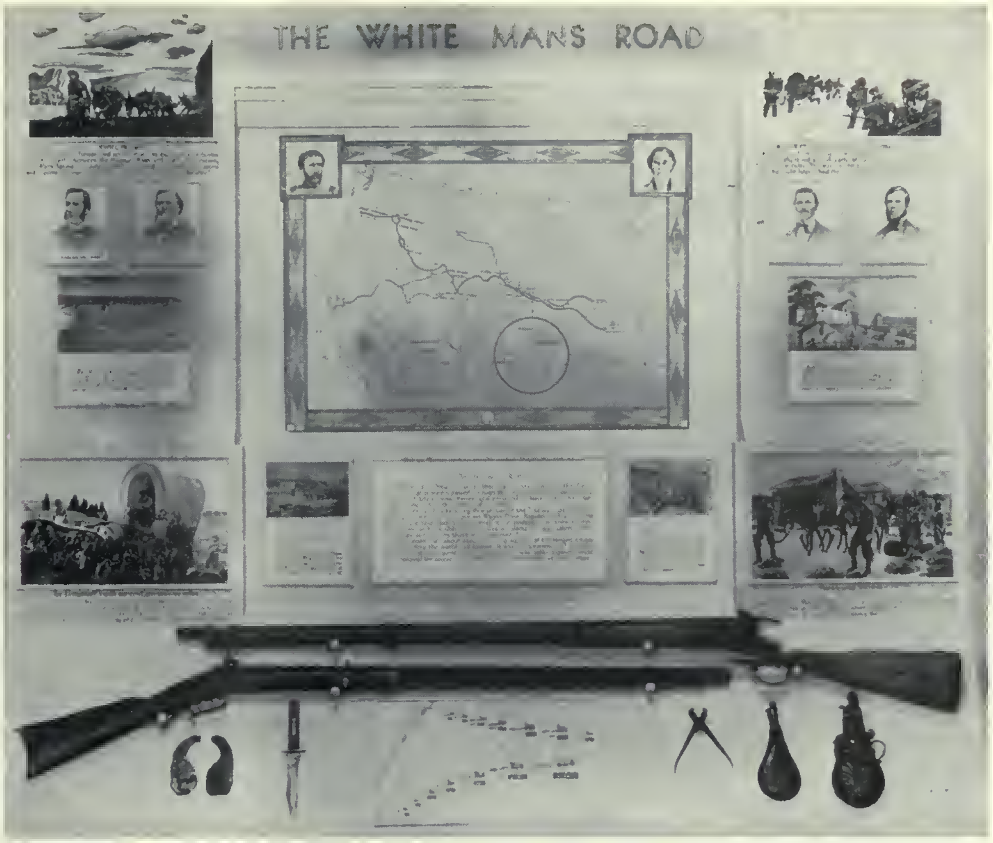
The modern history of the Guernsey area began more than 100 years ago with the coming of the Teton Dakota Indians, the Cheyennes and the Arapahoes, who came west on horses from their earlier homes east of the Mississippi. Close on the influx of the Indians came the first white men in 1812, a party led by Robert Stuart, eastward bound from Astoria on the Oregon coast. Stuart's party chose to follow the North Platte River across eastern Wyoming and western Nebraska, a route followed later by the hundreds of thousands of emigrants on their way westward.

The old Oregon Trail is not so far from the Guernsey Museum. Ruts cut deeply into chalk material by covered wagons remain as evidence of the early wagon trains. Register Cliff is 2 miles southeast of the town of Guernsey. On this cliff the pioneers carved their names through the migration period from 1840 to 1880.

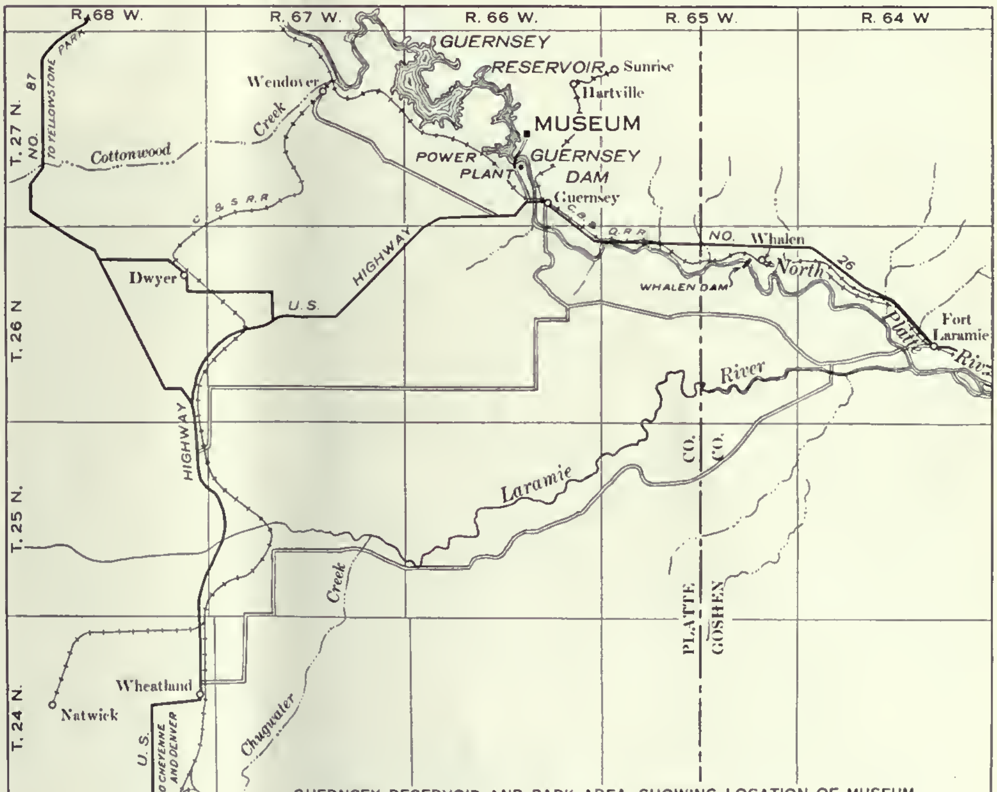
Trouble between the Indians and white men, the establishment of Army posts in the West, and the working out of treaties between the two races were all important in this area. The cattle industry moved in on the open range, iron and copper mines were developed, towns grew up, the railroads came, and irrigation made agriculture possible in spite of deficient rainfall.

The Exhibit Arrangements

All of this history is told in carefully prepared exhibits arranged in logical and chron-



Museum Case No. 6. The North Platte Valley Becomes the White Man's Road



GUERNSEY RESERVOIR AND PARK AREA. SHOWING LOCATION OF MUSEUM ological order in the cases. The exhibits consist of maps, charts, illustrations, three dimensional models and miniature groups prepared by skilled artists. Specimens and relics are included when they serve to interpret portions of the historical background.

The following list of main subjects of the display cases indicates the general outline of the museum story:

No. 1—Geology and fossil remains.
No. 2—Temperature, rainfall, topography, soil, and animal life.
No. 3—Evidence of prehistoric man.
No. 4—Indian inhabitants of 100 years ago.
No. 5—The Cheyenne man of action.
No. 6—The North Platte Valley becomes the white man's road.
No. 7—Emigrants encamped near Register Cliff in the 1840's. (Diorama.)
No. 8—Departure of the Indians.
No. 9—The open range cattle industry.
No. 10—Changed conditions in the cattle industry.
No. 11—Mines, towns, and railroads.
No. 12—The search for water in an arid land.
No. 13—Construction of Guernsey Dam and Power Plant.
No. 14—Benefits of Guernsey Dam including irrigation, power, and recreation.

Of these 14 cases, 10 are now completed and installed. Cases Nos. 1, 7, 13, and 14 have not yet been completed. It is planned eventually to install a relief model of the North Platte project in the open space of one of the exhibit halls.

The design and construction of the museum were supervised by the National Park Service. The building was constructed by enrollees of CCC Camp BR–9 under the direct supervision of Camp Superintendent J. H. Coffman and Architect Roland G. Pray. John Ewers, of the National Park Service museum planning staff at Berkeley, Calif., planned the museum exhibits. He visited southeastern Wyoming for field studies of significant archaeological and historical sites near Guernsey, interviewed early settlers, viewed representative collections of Indian artifacts and historical relics, and examined records in the project records in the Bureau of Reclamation office at Guernsey, in the State historical library at Cheyenne, and in the University of Wyoming library at Laramie. E. A. Hummel, associate historian of the university, gave valuable assistance in the research studies. The advice of Dr. Carl Russell and other members of the National Park Service museum planning staff who visited the museum and assisted in the preparation of the exhibits at Berkeley was very helpful in bringing the museum to successful completion.

C. F. Gleason, superintendent of power for the Bureau of Reclamation at Guernsey, represented the Bureau of Reclamation during the development of the park, which was turned over to him for administration in October 1937. The park and museum are located 3 miles north of United States Highway No. 26, about 70 miles west of Scotts Bluff, Nebr. The tourist, as well as the nearby farmer or dry-land rancher, will find the museum worthy of a visit, and the picnic groves a restful place to spend a hot summer's day.

Gov. Culbert O. Olson; Ralph Lowry, construction engineer, Shasta Dam, Central Valley project, California; and Frank Clark, director of State division of public works

Clean Ditches

(*Continued from page 182*)

intervals to prevent the maturing of any weed seeds.

Weed-competing grasses consume a relatively small amount of water compared with weeds, willows, and other useless growths and pay dividends in controlling weeds and providing valuable feed for livestock. Conserving water by preventing transpiration water losses from useless plants is conserving an agricultural resource for present and future use.

Showing of Irrigation Film

THE film Fundamentals of Irrigation was shown at three April meetings of the rural farm center organization on the Truckee Storage project, F. M. Spencer, acting construction engineer, being present on each occasion. County Agent H. E. Boerlin furnished the projection equipment and handled the showing of the film at all meetings.

Glenn County Fair, Orland Project

A WPA grant sufficient to complete the construction of the new home for the Glenn County Fair on the Orland project was secured during the month of April, and it is expected that 100 men will be employed during the summer. The total cost of the program is expected to be in excess of $100,000, and when complete, the plant will be one of the best in the State of California.

Orland Water Supply

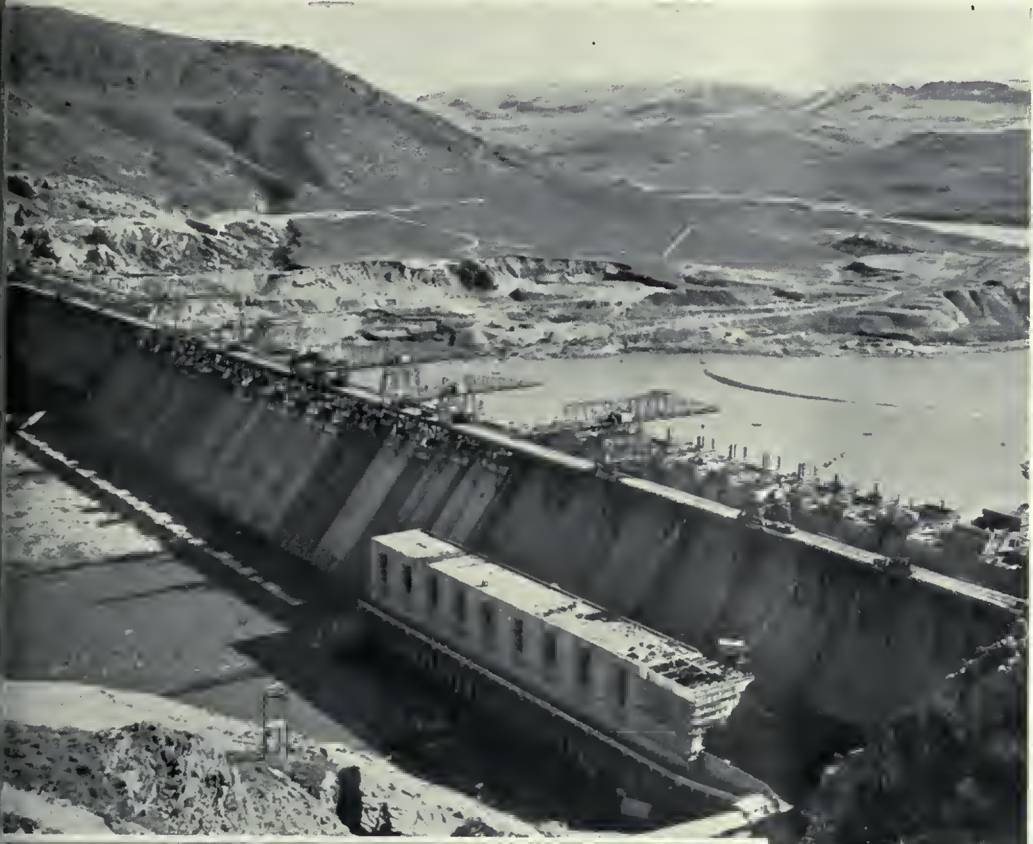
ALL irrigation water diverted for use on the Orland project during April came from natural flow sources and was more than sufficient for all needs. The run-off at Stony Gorge Dam for the season, approximately 290,000 acre-feet, was between six and seven times as great as that of the previous year. To April 30 of the present year 188,000 acre-feet had passed over the spillway at Stony Gorge Dam, whereas last year no water was spilled.

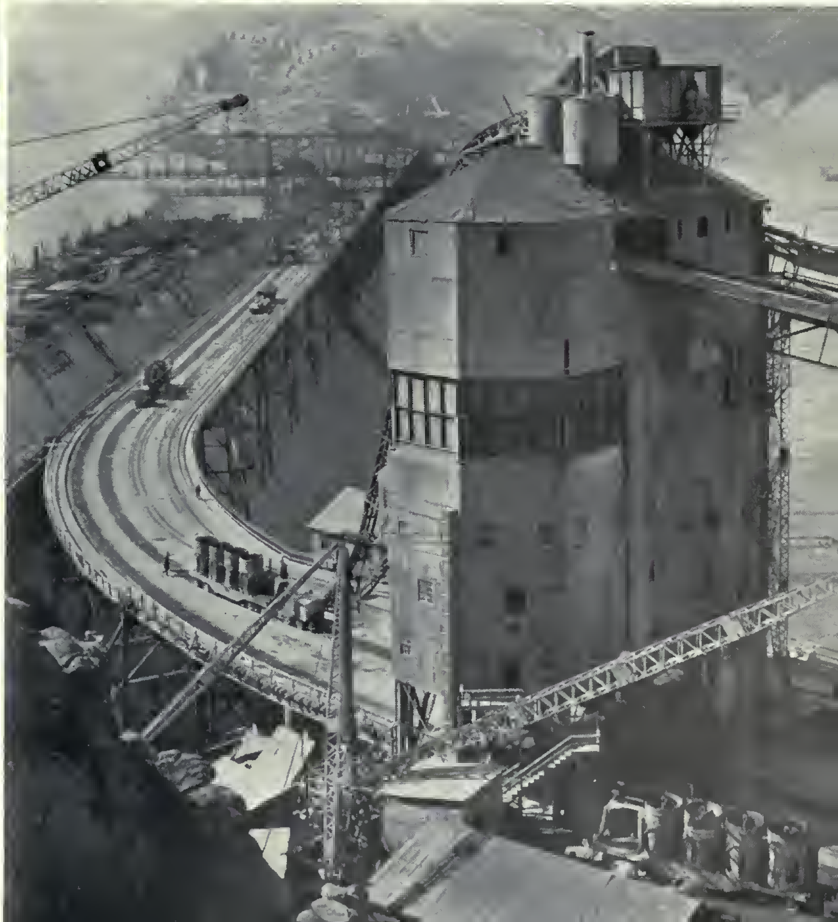
Orland Farm Operations

MECHANIZATION of the farm on the Orland project, California, continues to spread and the change is quite noticeable. Tractors, power-driven mowing machines, headers, binders, combines, and hay-baling outfits are common sights. The new power-driven mowing machines seem especially efficient and some cut an 8-foot swath. Many ingeniously contrived conversions of old trucks and passenger cars to tractors are to be seen working in the fields and apparently doing the work of more costly machines.

CONCRETING AT GRAND COULEE DAM

begins its last big season. Water now being released through tunnels in the dam will in June and July plunge over the center top creating a 250-foot waterfall. Grandstand seats are provided for visitors





The above group of 17 engineers and citizens representing the water and power committee of the Los Angeles Chamber of Commerce visited the All-American Canal and Gila projects on April 20, 1940

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CUT ALONG THIS LINE

Commissioner,
Bureau of Reclamation,
Washington, D. C.

(Date). . . . .

Sir: I am enclosing my check [1] (or money order) for $1.00 to pay for a year's subscription to The Reclamation Era.

Very truly yours,

June 1940.

(Name). . . . .

Address). . . . .

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Projects under construction or operated in whole or in part by the Bureau of Reclamation

Project	Office	Official in charge		Chief clerk	District counsel	
		Name	Title		Name	Address
All-American Canal	Yuma, Ariz.	Leo J. Foster	Construction engineer	J. C. Thrailkill	R. J. Coffey	Los Angeles, Calif.
Altus	Altus, Okla	Russell S. Lieurance	Construction engineer	Edgar A. Peek	H. J. S. Devries	El Paso, Tex.
Belle Fourche	Newell, S. Dak	F. C. Youngblutt	Superintendent	J. P. Siebeneicher	W. J. Burke	Billings, Mont.
Boise	Boise, Idaho	R. J. Newell	Construction engineer	Robert B. Smith	B. E. Stoutemyer	Portland, Oreg.
Boulder Canyon [1]	Boulder City, Nev	Irving C. Harris	Director of power	Cail H. Baird	R. J. Coffey	Los Angeles, Calif.
Buffalo Rapids	Glendive, Mont	Paul A. Jones	Construction engineer	Edwin M. Bean	W. J. Burke	Billings, Mont.
Buford-Trenton	Williston, N. Dak	Parley R. Neeley	Resident engineer	Robert L. Newman	W. J. Burke	Billings, Mont.
Carlsbad	Carlsbad, N. Mex	L. E. Foster	Superintendent	E. W. Shepard	H. J. S. Devries	El Paso, Tex.
Central Valley	Sacramento, Calif	W. R. Young	Supervising engineer	E. R. Mills	R. J. Coffey	Los Angeles, Calif.
Shasta Dam	Redding, Calif	Ralph Lowry	Construction engineer		R. J. Coffey	Los Angeles, Calif.
Friant division	Friant, Calif	R. B. Williams	Construction engineer		R. J. Coffey	Los Angeles, Calif.
Delta division	Antioch, Calif	Oscar G. Boden	Construction engineer		R. J. Coffey	Los Angeles, Calif.
Colorado-Big Thompson	Estes Park, Colo	Porter J. Preston	Supervising engineer	C. M. Voyen	J. R. Alexander	Salt Lake City, Utah.
Colorado River	Austin, Tex	Ernest A. Moritz	Construction engineer	William F. Sha	H. J. S. Devries	El Paso, Tex.
Columbia Basin	Coulee Dam, Wash	F. A. Banks	Supervising engineer	C. B. Funk	B. E. Stoutemyer	Portland, Oreg.
Deschutes	Bend, Oreg	D. S. Stuver	Construction engineer	Noble O. Anderson	B. E. Stoutemyer	Portland, Oreg.
Gila	Yuma, Ariz	Leo J. Foster	Construction engineer	J. C. Thrailkill	R. J. Coffey	Los Angeles, Calif.
Grand Valley	Grand Junction, Colo	W. J. Chiesman	Superintendent	Emil T. Ficenec	J. R. Alexander	Salt Lake City, Utah.
Humboldt	Reno, Nev	Floyd M. Spencer	Construction engineer [2]		J. R. Alexander	Salt Lake City, Utah
Kendrick	Casper, Wyo	Irvin J. Matthews	Construction engineer [2]	George W. Lyle	W. J. Burke	Billings, Mont.
Klamath	Klamath Falls, Oreg	B. E. Hayden	Superintendent	W. I. Tingley	B. E. Stoutemyer	Portland, Oreg.
Milk River	Malta, Mont	H. H. Johnson	Superintendent	E. E. Chabot	W. J. Burke	Billings, Mont.
Minidoka	Rupert, Idaho	Stanley R. Marean	Superintendent	G. C. Patterson	B. E. Stoutemyer	Portland, Oreg.
Minidoka Power Plant	Rupert, Idaho	Samuel A. McWilliams	Resident engineer		B. E. Stoutemyer	Portland, Oreg.
Mirage Flats	Hemingford, Nebr	Denton J. Paul	Construction engineer		W. J. Burke	Billings, Mont.
Moon Lake	Provo, Utah	E. O. Larson	Construction engineer	Francis J. Farrell	J. R. Alexander	Salt Lake City, Utah.
North Platte	Guernsey, Wyo	C. F. Cleason	Superintendent of power	A. T. Stimpfig	W. J. Burke	Billings, Mont.
Ogden River	Provo, Utah	E. O. Larson	Construction engineer	Francis J. Farrell	J. R. Alexander	Salt Lake City, Utah.
Orland	Orland, Calif	D. L. Carmody	Superintendent	W. D. Funk	R. J. Coffey	Los Angeles, Calif.
Owyhee	Boise, Idaho	R. J. Newell	Construction engineer	Robert B. Smith	B. E. Stoutemyer	Portland, Oreg.
Parker Dam Power	Parker Dam, Calif	E. C. Koppen	Construction engineer	George B. Snow	R. J. Coffey	Los Angeles, Calif.
Pine River	Vallecito, Colo	Charles A. Burns	Construction engineer	Frank E. Gawn	J. R. Alexander	Salt Lake City, Utah.
Rapid Valley	Rapid City, S. D	Horace V. Hubbell	Construction engineer	Jos. P. Siebeneicher	W. J. Burke	Billings, Mont.
Provo River	Provo, Utah	E. O. Larson	Construction engineer	Francis J. Farrell	J. R. Alexander	Salt Lake City, Utah.
Rio Grande	El Paso, Tex	L. R. Fiock	Superintendent	H. H. Berryhill	H. J. S. Devries	El Paso, Tex.
Elephant Butte Power Plant	Elephant Butte, N. Mex	C. O. Dale	Acting Resident engineer	H. H. Berryhill	H. J. S. Devries	El Paso, Tex.
Riverton	Riverton, Wyo	H. D. Comstock	Superintendent	C. B. Wentzel	W. J. Burke	Billings, Mont.
Shoshone	Powell, Wyo	L. J. Windle	Superintendent [2]	L. J. Windle [2]	W. J. Burke	Billings, Mont.
Heart Mountain division	Cody, Wyo	Walter F. Kemp	Construction engineer	L. J. Windle [2]	W. J. Burke	Billings, Mont.
Sun River	Fairfield, Mont	A. W. Walker	Superintendent		W. J. Burke	Billings, Mont.
Truckee River Storage	Reno, Nev	Floyd M. Spencer	Construction engineer [2]		J. R. Alexander	Salt Lake City, Utah.
Tucumcari	Tucumcari, N. Mex	Harold W. Mutch	Engineer	Charles L. Harris	H. J. S. Devries	El Paso, Tex.
Umatilla (McKay Dam)	Pendleton, Oreg	C. L. Tice	Reservoir superintendent		B. E. Stoutemyer	Portland, Oreg.
Uncompahgre: Repairs to canals	Montrose, Colo	Herman R. Elliott	Construction engineer [2]	Ewalt P. Anderson	J. R. Alexander	Salt Lake City, Utah.
Upper Snake River Storage [3]	Ashton, Idaho	I. Donald Jerman	Construction engineer [2]	Emmanuel V. Hillius	B. E. Stoutemyer	Portland, Oreg.
Vale	Vale, Oreg	C. C. Ketchum	Superintendent		B. E. Stoutemyer	Portland, Oreg.
Yakima	Yakima, Wash	J. S. Moore	Superintendent	Conrad J. Ralston	B. E. Stoutemyer	Portland, Oreg.
Roza division	Yakima, Wash	Charles E. Crownover	Construction engineer	Alex S. Harker	B. E. Stoutemyer	Portland, Oreg.
Yuma	Yuma, Ariz	C. B. Elliott	Superintendent	Jacob T. Davenport	R. J. Coffey	Los Angeles, Calif.

[1] Boulder Dam and Power Plant.

[2] Acting.

[3] Island Park and Grassy Lake Dams.

Projects or divisions of projects of Bureau of Reclamation operated by water users

Project	Organization	Office	Operating official		Secretary	
			Name	Title	Name	Address
Baker (Thief Valley division) [1]	Lower Powder River irrigation district	Baker, Oreg	A. J. Ritter	President	F. A. Phillips	Keating
Bitter Root [4]	Bitter Root irrigation district	Hamilton, Mont	C. R. Walsh	Manager	Elsie H. Wagner	Hamilton.
Boise [1]	Board of Control	Boise, Idaho	Wm. H. Tuller	Project manager	L. P. Jensen	Boise.
Boise [1]	Black Canyon irrigation district	Notus, Idaho	W. H. Jordan	Superintendent	L. M. Watson	Caldwell.
Burnt River	Burnt River irrigation district	Huntington, Oreg	Edward Sullivan	President	Harold H. Hursh	Huntington.
Frenchtown	Frenchtown irrigation district	Frenchtown, Mont	Edward Donlan	President	Ralph P. Schaffer	Huson.
Fruitgrowers Dam	Orchard City Irrigation Co	Austin, Colo	S. F. Newman	Superintendent	A. W. Lenning	Austin.
Grand Valley, Orchard Mesa [3]	Orchard Mesa irrigation district	Grand Junction, Colo	C. W. Tharp	Superintendent	C. J. McCormich	Grand Jctn.
Humboldt	Pershing County water conservation district	Lovelock, Nev	Roy F. Meffley	Superintendent	C. H. Jones	Lovelock.
Huntley [4]	Huntley irrigation district	Ballantine, Mont	E. E. Lewis	Manager	H. S. Elliott	Ballantine
Hyrum [3]	South Cache W. U. A	Wellsville, Utah	B. L. Mendenhall	Superintendent	Harry C. Parker	Logan.
Klamath, Langell Valley [1]	Langell Valley irrigation district	Bonanza, Oreg	Chas. A. Revell	Manager	Chas. A. Revell	Bonanza.
Klamath, Horsefly [1]	Horsefly irrigation district	Bonanza, Oreg	Henry Schmor, Jr	President	Dorothy Eyers	Bonanza.
Lower Yellowstone [4]	Board of Control	Sidney, Mont	Axel Persson	Manager	Axel Persson	Sidney.
Milk River: Chinook division [4]	Alfalfa Valley irrigation district	Chinook, Mont	A. L. Benton	President	R. H. Clarkson	Chinook.
	Fort Belknap irrigation district	Chinook, Mont	H. B. Bonefright	President	L. V. Bogy	Chinook.
	Zurich irrigation district	Harlem, Mont	C. A. Watkins	President	H. M. Montgomery	Chinook.
	Harlem irrigation district	Harlem, Mont	Thos. M. Everett	President	Geo. H. Tout	Harlem.
	Paradise Valley irrigation district	Zurich, Mont	R. E. Musgrove	President	J. F. Sharples	Zurich.
Minidoka: Gravity [1]	Minidoka irrigation district	Rupert, Idaho	Frank A. Ballard	Manager	O. W. Paul	Rupert.
Pumping	Burley irrigation district	Burley, Idaho	Hugh L. Crawford	Manager	Frank O. Redfield	Burley.
Gooding [1]	Amer. Falls Reserv. Dist. No. 2	Gooding, Idaho	S. T. Baer	Manager	Ida M. Johnson	Gooding.
Newlands [3]	Truckee-Carson irrigation district	Fallon, Nev	W. H. Wallace	Manager	H. W. Emery	Fallon.
North Platte: Interstate division [4]	Pathfinder irrigation district	Mitchell, Nebr	T. W. Parry	Manager	Flora K. Schroeder	Mitchell.
Fort Laramie division [4]	Gering-Fort Laramie irrigation district	Gering, Nebr	W. O. Fleenor	Superintendent	C. C. Klingman	Gering.
Fort Laramie division [4]	Goshen irrigation district	Torrington, Wyo	Floyd M. Roush	Superintendent	Mary E. Harroch	Torrington.
Northport division [4]	Northport irrigation district	Northport, Nebr	Mark Iddings	Manager	Mabel J. Thompson	Bridgeport.
Ogden River	Ogden River W. U. A	Ogden, Utah	David A. Scott	Superintendent	Wm. P. Stephens	Ogden.
Okanogan [1]	Okanogan irrigation district	Okanogan, Wash	Nelson D. Thorp	Manager	Nelson D. Thorp	Okanogan.
Salt Lake Basin (Echo Res.) [3]	Weber River Water Users' Assn	Ogden, Utah	D. D. Harris	Manager	D. D. Harris	Layton.
Salt River [2]	Salt River Valley W. U. A	Phoenix, Ariz	H. J. Lawson	Superintendent	F. C. Henshaw	Phoenix.
Sanpete:						
Ephraim division	Ephraim Irrigation Co	Ephraim, Utah	Jos. H. Thomson	President	John K. Olsen	Ephraim.
Spring City division	Horseshoe Irrigation Co	Spring City, Utah	Vivian Larson	President	James W. Blain	Spring City
Shoshone: Garland division [4]	Shoshone irrigation district	Powell, Wyo	Paul Nelson	Acting irri. supt	Harry Barrows	Powell.
Frannie division [4]	Deaver irrigation district	Deaver, Wyo	Floyd Lucas	Manager	R. J. Schwendiman	Deaver.
Stanfield	Stanfield irrigation district	Stanfield, Oreg	Leo F. Clark	Superintendent	F. A. Baker	Stanfield.
Strawberry Valley	Strawberry Water Users' Assn	Payson, Utah	S. W. Grotegut	President	E. G. Breeze	Payson.
Sun River: Fort Shaw division [4]	Fort Shaw irrigation district	Fort Shaw, Mont	C. L. Bailey	Manager	C. L. Bailey	Fort Shaw.
Greenfields division [4]	Greenfields irrigation district	Fairfield, Mont	A. W. Walker	Manager	H. P. Wangen	Fairfield.
Umatilla, East division [1]	Hermiston irrigation district	Hermiston, Oreg	E. D. Martin	Manager	Enos D. Martin	Hermiston.
West division [1]	West Extension irrigation district	Irrigon, Oreg	A. C. Houghton	Manager	A. C. Houghton	Irrigon.
Uncompahgre [3]	Uncompahgre Valley W. U. A	Montrose, Colo	Jesse R. Thompson	Manager	H. D. Galloway	Montrose.
Upper Snake River Storage	Fremont-Madison irrigation district	Ashton, Idaho	H. G. Fuller	President	John T. White	St. Anthony.
Weber River	Weber River W. U. A	Ogden, Utah	D. D. Harris	Manager	D. D. Harris	Ogden.
Yakima, Kittitas division [1]	Kittitas reclamation district	Ellensburg, Wash	C. C. Hughes	Acting manager	G. L. Sterling	Ellensburg.

[1] B. E. Stoutemyer, district counsel, Portland, Oreg.

[2] R. J. Coffey, district counsel, Los Angeles, Calif.

[3] J. R. Alexander, district counsel, Salt Lake City, Utah.

[4] W. J. Burke, district counsel, Billings, Mont.

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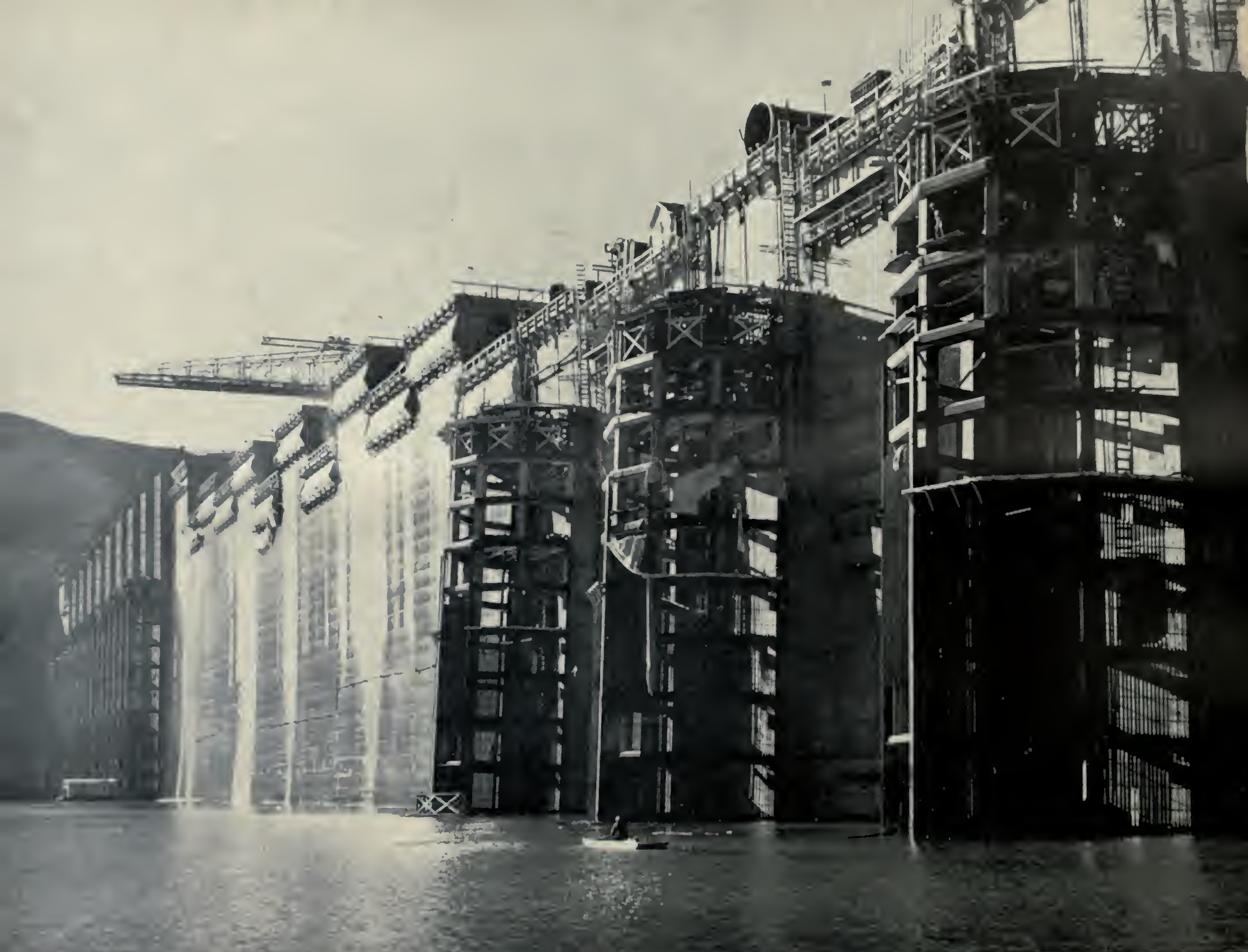
SALLIE A. B COE, *Editor*.



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DEPARTMENT OF THE INTERIOR

THE RECLAMATION ERA

JULY 1940

Raymond F. Walter

1873–1940

Raymond F. Walter, engineer in the service of the Bureau of Reclamation for 37 years and its chief engineer for the past 15 years, died of a heart attack in Fresno, Calif., June 30, at the age of 66 years.

Mr. Walter had been in ill health for some time, and late this spring was compelled to take brief absences from his office at Denver, Colo. He spent the month of May in California hoping a complete rest would bring relief. Feeling better he visited the construction work in progress at Friant Dam on June 29, and while there he became suddenly ill and died in a Fresno hospital on June 30.

John C. Page, commissioner, Bureau of Reclamation, in notifying Secretary of the Interior Harold L. Ickes, of the chief engineer's death, said:

"With deep regret I must tell you that the Bureau of Reclamation has lost its most valued employee, Chief Engineer Raymond F. Walter. His death leaves a gap which can never quite be filled. Mr. Walter was the country's recognized authority on heavy construction. The Bureau will miss him sorely. He was respected and loved by all of us who had worked with and for him these many years."

Secretary Ickes then made the following statement:

"The death of Chief Engineer Walter after a lifetime of service to the Bureau of Reclamation and the Department of the Interior is a severe blow. For 15 years Mr. Walter had been in active charge of what is generally recognized as the greatest engineering office in the world—the Denver engineering headquarters of the Bureau of Reclamation. His services were outstanding. His unfailing loyalty to his organization, to his Bureau and his Department, and to the United States Government, has provided an example for the thousands of younger men working under him. His unexpected death is a shock to the whole Department."

Mr. Walter was born in Chicago, Ill., October 31, 1873. His father was a printer and publisher who moved the family to Colorado by covered wagon during the gold rush of the late seventies when Mr. Walter was 5 years old.

Mr. Walter attended public grammar and high schools of Fort Collins, Colo., and received the degree of bachelor of science in civil engineering from the Colorado Agricultural College in June 1893. After graduation he obtained a job with E. E. Baker, a pioneer civil engineer at Greeley, Colo., with the understanding that the employment would last 30 days. He remained with the Baker firm nearly 10 years, rising to junior partner. The Baker firm had an extensive engineering practice in Colorado, Wyoming, and New Mexico during the late nineties. The depletion of stream flow in snow-fed rivers heading in the Rocky Mountains was already beginning to cause diastrous water shortages, and many canal operators were turning to the storage of water as a solution.

Mr. Walter was engineer and superintendent in charge of construction of the Terry Lake Reservoir, Colorado, one of the first two attempts to store water in inland basins for later irrigation. The other reservoir had been started earlier by Mr. Baker and was under construction at the same time.

While Mr. Walter was acquiring knowledge of canal and reservoir construction in private practice, he was accumulating other valuable experience. He was twice elected county surveyor of Weld County, and twice city engineer of Greeley. He also designed and built much of the original sewer systems for Greeley and Eaton, Colo. He made the survey for the Greeley mountain water system, and was deputy State Engineer of Colorado in charge of measurement of streams and canals.

On June 17, 1902 the Bureau of Reclamation was established by Congress. Less than a year afterwards, on May 20, 1903, Mr. Walter entered the service of the new organization as an engineer, at a yearly salary of $1,800 and was detailed to irrigation surveys and investigations in South Dakota. His experience, ability, and good work brought him successive promotions. He was appointed engineer in charge of the Belle Fourche project in 1904; supervising engineer for the Central Division, comprising Colorado, Kansas, Oklahoma, South Dakota, Nebraska, and Wyoming, in 1909: assistant chief of construction, in 1916; assistant chief engineer, in 1920; and finally, on May 1, 1925, chief engineer for the Bureau, with field headquarters at Denver, Colo.

Mr. Walter supervised the construction of many important Federal irrigation structures during his long career with the Bureau. In addition to the Belle Fourche project and dam in South Dakota he supervised the construction of the Grand Valley project, Colorado, and the diversion dam, canal, and tunnels; the completion of the Gunnison tunnel and the Uncompahgre project, Colorado, and the North Platte project, Wyoming, and its Pathfinder Dam and Minatare Reservoir.

Twice under Mr. Walter's supervision as chief engineer the Bureau erected the highest dam of its type in the country—the Owyhee Dam (417 feet) on the Owyhee project, Oregon-Idaho, and Boulder Dam (726 feet), Arizona-Nevada. Owyhee was completed in 1932, Boulder in 1935.

The construction of Grand Coulee Dam in Washington and Shasta Dam in California, largest and second largest concrete dams in the world, was begun under Mr. Walter's guidance. Grand Coulee is the main feature of the Columbia Basin project, which will eventually open 1,200,000 acres of land to irrigation. Shasta is the major dam on the great Central Valley project.

Great progress in the benefits brought by Reclamation appears during the period 1925-40, while Mr. Walter was chief engineer. In 15 years the combined water storage capacity of reservoirs built by the Bureau more than quadrupled, from 10,325,053 acre-feet to 47,121,170.

Commissioner Page attended the funeral held July 3. Burial was in the Fairmont Cemetery, Denver, Colo.

Sinclair O. Harper, who has been assistant chief engineer of the Bureau of Reclamation, has been designated acting chief engineer.

Surviving Mr. Walter are his widow, Mrs. Lillian Leone Phillips Walter, a daughter, and a son.

PRICE
ONE
DOLLAR
A YEAR

THE RECLAMATION ERA

VOLUME 30 • JULY 1940 • NUMBER 7

Reclamation Engineering Number

Reclamation—A Builder of the Nation

Our people as a whole will profit (from Reclamation), for successful homemaking is but another name for upbuilding of the Nation.—*Excerpt from President Theodore Roosevelt's message to Congress, December 1901.*

THE engineering work of the Bureau of Reclamation has brought water, power, and light to western areas with a population of 4½ million.

One million farmers and townspeople gain their livelihood from federally irrigated land. Another three and a half million get more than half their power and light needs from low-cost hydroelectric developments as a byproduct.

Completion of the Bureau of Reclamation's current construction program will double the number of people benefited—serving areas with a population exceeding 9,000,000.

This is engineering achievement, the result of 38 years of work under the Reclamation law of June 17, 1902, which was sponsored by President Theodore Roosevelt to bring about a permanent, beneficial development of the West.

The Reclamation law of 1902 was evolutionary. Previously, although the Federal Government's homestead and other laws had encouraged western settlement and the development of the country as a whole, little aid had been given the settler in combating nature's obstacles, in attaining a reasonable security. The settler's struggle in the 700 million acres of arid and mountainous land sprawling west of the 100th meridian was too often a losing one. The ruins of abandoned farms and ghost towns throughout the West are eloquent of that fact.

Water was essential in western agriculture. Except for comparatively small areas along the northern Pacific coast and among the mountain peaks, the annual rainfall averaged from 3 to 20 inches. Water must be had, if plants and man were to live, it was acknowledged. Irrigation was the only solution.

Federal sponsorship of irrigation accordingly was urged for many years before the enactment of the Reclamation law of 1902. The Western States were young, sparsely populated, with severely limited taxable resources. Private initiative and cooperative effort had provided for the irrigation of 9,000,000 acres. The value and permanency of the contribution irrigation could make to western development had been demonstrated.

Further irrigation development, without participation by the Federal Government, seemed remote, because of increasingly difficult engineering and financial problems which were being encountered as the simple water diversions were exhausted. The problem of extension of irrigation began to attract national attention and interest.

Reclamation Engineering

THE Denver office this month is playing host to the American Society of Civil Engineers, and therefore this issue is devoted to Reclamation Engineering.

In the Reclamation Law of 1902, the Congress definitely established the principle that development of the West is a national consideration. The conservation of the limited water resources of the arid West, to provide homemaking opportunities for large numbers of Americans, was made a national objective.

In its financial aspects, the Reclamation program differs from other programs for internal improvement under Federal auspices. In the original plan, proceeds from the sale of public lands were to be invested in irrigation works in the Western States. These funds were not to be expended as gifts but were to be repaid by water users into the reclamation revolving fund, from which appropriation for additional construction could be made. The sources of revenues to this fund necessarily have been increased, but the repayment principle has remained unchanged.

In its operation, the Federal Reclamation program since 1902 has embraced construction of projects for irrigation of desert lands and construction of water-storage works for the provision of supplemental water supplies for irrigated areas, originally privately developed, but which were rendered insecure and unproductive by water shortages. Although new lands irrigated by Federal projects in 38 years represent only 1 percent of the total cropped area of the United States, they contribute materially to the welfare of a large section of the population.

Since Reclamation seeks, as a conservation activity, prudent economical utilization of the water resources of the West, the development of hydroelectric power in connection with and incidental to irrigation works has been recognized as a means of spreading more widely the benefits of this public program.

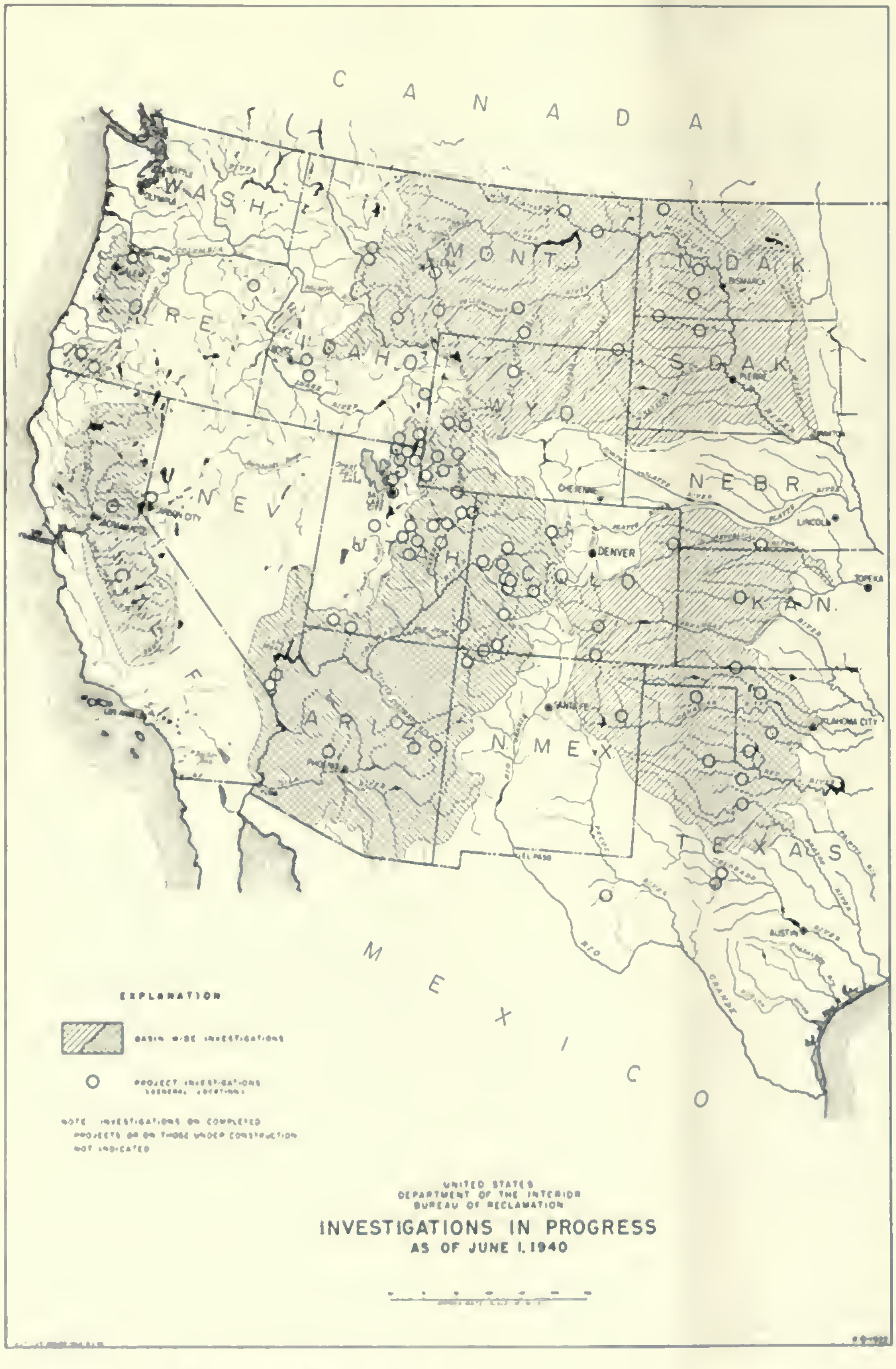
On the 52,500 irrigated farms created by the program and in the 258 cities and towns dependent on them live 904,000 persons. Expenditures made in construction of the projects have been widely distributed. The purchasing power of the developed project areas fulfills the prediction that reclamation of the arid lands would broaden the market for the manufactured goods of the industrial centers to the eastward.

All these benefits from Reclamation—the diversified complementary crop production, the creation of homes and livelihoods, the large and growing market for eastern and other industrial centers, the generation of low-cost electric energy, as well as the creation of recreational and wildlife areas—all make Reclamation a builder of the Nation.

Preconstruction—Project Planning

PROJECT-planning and project-investigation activities of the Bureau of Reclamation are carried on under the basic authority of the Reclamation Act of June 17, 1902, which reads in part as follows (regarding the Reclamation fund thereby created):

"to be used in the examination and surveys and the construction and maintenance of irrigation works for the storage, diversion, and development of water for the arid and semiarid lands."



UNITED STATES
DEPARTMENT OF THE INTERIOR
BUREAU OF RECLAMATION
INVESTIGATIONS IN PROGRESS
AS OF JUNE 1, 1940

The Reclamation Project Act of 1939 reads in part as follows:

"No expenditures for the construction of any new project, new division of a project, or new supplemental works on a project shall be made, nor shall estimates be submitted therefor, by the Secretary until after he has made an investigation thereof and has submitted to the President and to the Congress his report and findings on—

"(1) the engineering feasibility of the proposed construction;

"(2) the estimated cost of the proposed construction;

"(3) the part of the estimated cost which can properly be allocated to irrigation and probably be repaid by the water users;

"(4) the part of the estimated cost which can properly be allocated to power and probably be returned to the United States in new power revenues;

"(5) the part of the estimated cost which can properly be allocated to municipal water supply or other miscellaneous purposes and probably be returned to the United States."

Thus the engineering and economic feasibility of a project must be determined and reported upon prior to the submission to the Bureau of the Budget of estimates for appropriation of funds for construction. By the provisions of that act, a project is authorized upon a finding by the Secretary of the Interior that the probable returns to the United States within the repayment period of 40 years equal the construction cost, less any proper allocation for flood control. Repayment, with interest at not less than 3 percent of the costs allocated to power, is required; and the cost, with interest not exceeding 3½ percent, of water supplies for municipal purposes must be repaid.

Appropriation of funds by the Congress must precede construction of a financially feasible project. If the Secretary of the Interior finds a project financially infeasible on the basis of the 1939 Reclamation Act, appropriation for construction must be preceded by specific authorization by the Congress.

Project planning by the Bureau of Reclamation revolves around irrigation. Its object is to plan for the utilization of available water resources in irrigation and for related purposes. The most desirable lands for irrigation must be selected, and consideration must be given to domestic and industrial water supply requirements, flood-control regulation, power

Upper: Stream gauging
Lower: Dam site drilling; drill core

Upper: Snow surveys
Lower: Land classification crew in the field

production, and other interests in water, as well as to interbasin and interstate interests where competitive uses of limited resources are involved.

The approaching exhaustion of usable water supplies in the arid and semiarid West makes basin-wide preliminary examinations necessary to insure proper selection of project areas for detailed consideration. A large part of the requisite basic data for these examinations is usually available. Soil surveys of varying detail now cover most of the suitable land areas and permit the rapid development of adequate reconnaissance land classifications. Existing run-off records or considerations of precipitation and run-off on comparable streams allow the determination of water supplies in sufficient detail and accuracy. When necessary, reservoir capacities are computed from a few basin cross sections tied together with center line stadia traverses. Costs of dams can be satisfactorily approximated from dam-site profiles and the application of an over-all unit cost for the yardage required by a standard cross-section, with this unit cost reflecting the yardage and special problems of spillway and outlet works. The experienced engineer using only hand instruments can also estimate costs of distribution systems with satisfactory accuracy. Power-plant costs may be computed from available data.

Available funds preclude extensive exploration programs for dam sites or detailed location surveys for canals prior to appropriation for construction; yet repayment contracts are required in advance of most construction. This necessitates a high degree of accuracy in the preliminary plans and cost estimates.

Cooperation and consultation with State and local groups, with benefit to all concerned, is the prevailing practice. Formal agreements are in force with a number of States, counties, and other interests. Project planning of the Bureau has entered a new and beneficial phase in the interdepartmental agreement of July 1939, with the War and Agricultural Departments providing for cooperation and consultation in project reports. This cooperation avoids duplication of surveys and conflicts in plan and function. Other agencies frequently consulted are the Biological Survey and the National Park Service. The Geological Survey, Weather Bureau, and Forest Service provide data for use in the investigations.

Designs and Specifications

ALMOST all phases of technical engineering are embraced in the preparation of the Bureau of Reclamation engineering designs. When funds are appropriated for a proposed project, preliminary design studies are initiated and carried on concurrently with the project investigations. The sources of information on which these studies are based are estimates of the available water supply and irrigation requirements, topographic surveys and maps, geological examinations, and reports on investigations of various character that indicate the controlling economic and engineering aspects of the contemplated work. From these studies are developed the concept of required capacities or proportions, the most suitable types and arrangements of necessary structures, treatment of particular physical features, comparative cost estimates, and the conditions under which the project must operate. Conclusions from these studies establish the plan upon which the final designs are based.

Beginning with the analyses of hydrologic studies made to determine the adequacy of the water supply, and including the design of dams for diversion or storage, outlet works for withdrawal from the reservoir, canals for distribution to the land, pumping plants, incidental power development and transmission, flood control, and other related features such as the relocation of highways and railroads, the design problem as a whole requires the skill of the hydraulic, civil, electrical, and mechanical engineer, the architect, geologist, and frequently of specialists in related branches of science.

Under the supervision and direction of a chief designing engineer, the component features of the project design are developed by separate groups or divisions particularly qualified to handle each type of work involved. The procedure as a whole is coordinated to produce the complete design. For example, estimates of water supply, determinations of reservoir storage capacities, establishments of spillway and outlet-works discharge requirements, preparation of hydrographs, and other questions of hydrology are referred to the hydraulic engineers; problems such as the selection of type and design of dams, design of structures, stress analyses, and location studies for canals, railroads, and highways are matters for the civil engineers; power-development problems involving analyses of operating heads, decisions as to the type, size, and arrangement of turbines and generating equipment, and methods of control and transmission are those of the electrical engineers; and the designs of spillway gates and hoists, outlet-works controls, trashracks and other mechanical installations are prepared by the mechanical engineers. The architectural group is charged with the preparation of all building designs and details and with the rendering of architectural treatments for large dams, power- and pumping-plant buildings and other structures. Increasing reliance is being placed on the geologist for the interpretation of geologic features as influencing the design of large and important structures.

All detailed designs, working drawings, and specifications for construction and for the purchase of materials are prepared in the Denver office. This permits the chief engineer closely to coordinate the design work with field construction operations, material requirements, and general administrative procedure. Special fabricated equipment, such as trashracks, bend gates, penstock valves, penstocks, and cranes, is furnished by respective manufacturers on specifications prepared by the design section. Installed major equipment, such as electrical generators, pumping units, and similar apparatus, is normally purchased on detailed specifications setting forth performance requirements.

Frequently unusual field conditions and requirements of an extraordinary character introduce problems that cannot be disposed of by ordinary design methods. Such demands may range from the need of a special design for an outlet or control valve or hydraulic shape to a comprehensive technical research of basic conditions and problems involved in work of magnitude for which no precedence of procedure exists. Questions of this latter character are referred to a division of technical investigations for mathematical analyses and physical research, including the development of required special testing procedure and equipment or apparatus. Photoelastic analyses by means of models are made to determine the nature and magnitude of stresses in complex structures or to investigate other phenomena incidental to elastic deformations.

The Denver laboratories of the Bureau of Reclamation are an important part of the designing organization. Many problems of design and construction are studied under various conditions, with the result that much progress has been made in the establishment of basic design criteria and in methods of processing and utilizing construction materials. The laboratories are established in three main divisions: Materials-testing, hydraulic, and photoelastic. Including sections for investigating concrete manufacture, soils, and paints and metals, the materials-testing division determines the suitability and strength of these materials and the best methods for their preparation, control, and utilization. Studies of hydraulic phenomena are made in the hydraulic laboratories by means of large-scale models, which are exact replicas of spillways, outlet works, gate structures, overflow crests, stilling pools, and other works controlling the flow of water.

The verification of anticipated results and observations of the efficiencies of designs and methods of construction have been undertaken, during the past 8 years, by the development and installation of various sensitive and accurate meters or other apparatus for observing and recording deflection, deformation, stress distribution, internal pressure, temperature variations, hydraulic phenomena, and other conditions in completed structures.

Behavior of concrete in large masses has been one of the major problems of designers and construction engineers. Characteristic volume changes in concrete due to temperature changes, variations in moisture content, and plastic flow introduce many problems in addition to those concerned with the analysis of stresses and the elastic deformations of the structures under load. Investigation of these problems has, in a large measure, been responsible for specifications for low-heat cements and developments in the design and construction of dams, such as restrictions in time and rate of concrete placement, and in depth of lift, improvements in mix and methods of placement, best arrangement of contraction joints, and utilization of artificial cooling to establish ultimately stable temperatures so that contraction joints subdividing the mass can be grouted and the structure made a monolith within the construction period.

Other special studies seeking the solutions of particular problems have resulted in contributions of general benefit to engineering science. Some of these have come from studies and research entirely within the Bureau's organization; others have resulted from collaboration with the engineering staffs of manufacturers furnishing equipment. Worthy of mention and attributable to the Bureau's designing organization is the development of the trial-load method of analyzing stresses in arch dams, methods for determining earthquake stresses in large monoliths, and methods for computing foundation settlements due to water load. Contributions in the field of reservoir-outlet control gates and valves include: The design of high-pressure, hydraulically balanced needle valves for large-diameter outlets; hydraulic rotor-actuated butterfly or pivot-type valves; butterfly valves with pivoted stems retractable into the leaf, so that the leaf and stem may be readily removed; control gates of the "paradox" type, which permit seating and unseating of large conduit penstock and intake gates by pure roller motion; paradox noncreeping control system for balanced needle valves; and hydraulically operated, unhoused large penstock inlet gates for use under high heads.

Construction

IN conformance with the policy adopted by the Department of the Interior in 1925, practically all new construction of the Bureau of Reclamation is performed under contracts awarded on the basis of competitive bids. These bids, which normally provide for the furnishing of all labor and the construction plant, are invited upon completion of project designs and issuance of specifications covering the requirements of the work.

The necessary materials and installed equipment are separately purchased by the Bureau and are furnished to the general contractor as needed. These purchases are likewise made after competitive bidding on specifications prepared by the Bureau.

Bureau of Reclamation forces sometimes build the camp for housing technical and administrative personnel, build access roads, electric power lines, railroad spurs, and other facilities necessary for the initiation and conduct of the work, and some other features.

Construction work regularly performed by Bureau forces is limited to that which is incidental to the maintenance and operation of completed projects. This work is diverse in character and is by no means negligible in volume. It includes repair and maintenance of power plants, power transmission lines, pumping plants, and of canals and their incidental structures. These various operations are normally under the direction of the project superintendent.

The field organization, normally headed by a construction engineer, consists of a staff of engineers, inspectors, laboratory technicians, and clerical and other administrative personnel as required. The organization of the construction engineer is responsible for laying out the work, inspection of performance and materials, testing of materials, and for obtaining compliance with the specification requirements. Administrative details include the preparation of periodic estimates of completed work for payment, routine and special reports to the office of the chief engineer, and matters generally relating to the conduct of the work. Field laboratories are established for the continuous testing of materials of construction to make certain that their selection, processing, and utilization are in accordance with specified requirements.

In the case of large projects including two or more distinct but definitely related features that in themselves constitute major undertakings, the field work may be under the general direction of a project supervising engineer and staff, with a construction engineer and his organization assigned to each major subdivision. Examples of this type of organization exist on the Central Valley project in California and the Colorado-Big Thompson project in Colorado.

The nature of construction involved in Bureau of Reclamation projects is widely diversified both in kind and extent. Works for the collection, storage, and distribution of water, with incidental power development and transmission, may range from relatively small projects involving a few simple structures and employing a small force to multiple-purpose projects of great magnitude such as Boulder Canyon, Columbia Basin, and Central Valley, each incorporating numerous features, and requiring hundreds of men in specialized fields. The scope of operations includes the construction of concrete and earth dams, canals and aqueducts, bridges, highways and railroads, power and pumping plants, and the driving of tunnels.

A close relationship exists between the development of construction methods and equipment and the magnitude of projects undertaken in recent years. Not only have the elements of capacity, durability, and speed of performance been reflected in the manufacture of equipment of entirely new design or in the adaptation of existing types of equipment to new fields of activity, but also these developments in equipment and construction plants and improvements in methods have made possible the accomplishment of work that otherwise might have been economically infeasible.

Progress in the construction of earth-fill dams and embankments is strikingly demonstrated by comparison of the team-and-fresno methods of the not-very-distant past with the present-day excavation and placing equipment such as elevating graders, tractor-drawn scrapers holding 30 or more cubic yards of material, fast-moving dump trucks of large capacity, and specially designed compacting equipment.

Signal developments have been made in the manufacture of concrete and methods of placement in construction of large concrete dams. At Grand Coulee Dam, for example, the aggregate processing plant has a rated capacity of 3,000 to 4,000 tons per hour and is designed to wash, screen, and separately store four sizes of gravel and three sizes of sand. The plant arrangement permits blending the sand sizes in desired proportions. An endless belt conveyor, 48 inches wide and 10,000 feet long, traveling at a speed of 700 feet per minute, delivers the prepared aggregate to storage bins at the mixing plant. Here rigid control of the mix is maintained by delivery of the cement, water, and various sizes of aggregate through an automatically operated and controlled batching plant to four 4-cubic-yard mixers. The cement, which is shipped in bulk, is unloaded at a distant railroad siding by power-operated vacuum pumps at the rate of 125 carloads per day; the cement is pumped by air through a 6-inch pipe line to storage silos at the mixing plant. The mixed concrete is discharged into 4-cubic-yard bottom-dump buckets and delivered to its point of placement by Diesel electric trains operating on a concreting trestle extending the length of the dam. The buckets are picked up from the trains and lowered to the forms by means of hammer-head cranes, which also move along the concreting trestle.

The concrete distribution system at Boulder Dam operated from a cableway, as will be the method of placement at Shasta Dam, a unit of the Central Valley project. An outstanding innovation at Shasta Dam, however, will be that seven cableways, each with a capacity of 20 tons and capable of handling 8-cubic-yard-capacity concrete buckets, will radiate from one control tower to tall towers operating on segmental runways with a curvature fixed by their radial distance from the central tower. This central or control tower will be 610 feet high, including a depth of 102 feet below ground for anchorage, and the radiating cableways will be connected at a point 460 feet above the ground surface. The aggregate will be delivered from the screening and processing plant, located at the site of the aggregate deposits, to the mixing plant at the dam site by a 9½-mile-long belt conveyor.

In the field of construction and installation of heavy power-plant machinery, typified by by the 150,000-horsepower hydraulic turbines with generators for the Grand Coulee power plant, many innovations have greatly accelerated construction schedules. Outstanding is the method developed for concreting the turbine scroll cases in place while under an hydrostatic pressure equivalent to the normal operating head, and the use of welded plate-steel casings with improved riveted field connections.

Boulder Dam was the first mass-concrete structure in which an embedded pipe system for the circulation of cooling water was used to dissipate the heat generated by the chemical action of setting concrete. Since many years would be required for such masses to cool naturally, accelerated cooling permits contraction joints to be grouted practically as construction progresses, thereby solving many problems of both design and construction. Embedded cooling systems are now employed on all large structures of mass concrete.

At Boulder also large steel penstocks were fabricated at the site of installation, a precedent. There and subsequently at Grand Coulee Dam, complete shops and equipment were installed, capable of bending, assembling, welding, testing, and X-raying completed joints on penstock sections up to 30 feet diameter. Pipes for Shasta Dam similarly will be fabricated at the site.

Dams

DAMS designed and constructed by the Bureau of Reclamation range in size from simple diversion structures of a few feet in height to dams of unprecedented proportions with the multiple purpose of irrigation storage, flood control, municipal and industrial water supply, and power development.

Through the years since the Federal Government began the construction of self-liquidating irrigation projects in the arid and semiarid Western States, the regional growth in population with corresponding agricultural and industrial development has demanded an increasing utilization of available water supplies. Early irrigation consisted very largely of simple diversion dams and dependence on unregulated stream flows; today these unregulated flows are insufficient for existing needs, and storage works are required for impounding surplus run-offs and flood flows. Storage dams have become larger and more expensive, and, as the better dam and reservoir sites have been utilized, less favorable locations have imposed added construction difficulties and costs.

The relation between the increasing costs and economic feasibility is a current problem of irrigation development. When the scope of the project is comprehensive, a solution is found in the construction of multiple-purpose dams; the cost of irrigation water is kept within practical limits, proper assessments are made for flood-control benefits, and the balance of the project cost is returned with revenues derived from the sale of industrial and domestic water and power.

Many of the early practices of the Bureau in dam design and construction have been outmoded or greatly altered. Such structures as Boulder, Grand Coulee, and Shasta Dams have introduced new and unprecedented problems of design and construction. Older dams, such as Roosevelt on the Salt River in Arizona, were constructed of rubble masonry containing from 60 to 70 percent of stone laid by hand and derrick with mortar and spalls, with the upstream face constructed of cut stone laid with close and well-pointed joints. Current construction employs concrete, manufactured and placed under rigid control. Aggregates are carefully selected and graded, with the maximum size of stone definitely limited; batching and mixing plants are designed automatically to secure predetermined proportions of aggregate, cement, and water and uniformity of mix; and placing procedure is systematic and in accordance with established standards. Contraction joints are placed at regular intervals to restrict and control the cracking of the concrete and later grouted to make the structure monolithic. In large structures of mass concrete, embedded pipe systems are provided for the circulation of cooling water to remove the heat generated from chemical action incidental to the hydration and setting of the cement. This provision enables the contraction joints to be grouted and the required stress distribution to be secured as construction progresses.

Similar improvements have been made in the design and construction of earth dams. Outworn empirical methods have been superseded by thorough preconstruction investigation of materials, careful theoretical design, and construction procedure in accordance with applicable principles of soil mechanics.

Since the work of the Bureau of Reclamation is distributed over the Western States, wide variations are encountered in climate, physical conditions, and construction facilities. Dams may be built in mountainous areas where the ruggedness of the terrain, limitations in working area, extreme low temperatures, and difficulties of access introduce unusual problems, or construction may be undertaken in the hot desert regions of the Southwest under conditions which likewise impose requirements of an extraordinary character and which necessitate special considerations with respect to types of structure and construction methods. Consequently, many combinations of function, relative economics, and local factors, such as character of the foundation geology, topography of the site, availability of materials of construction, and special requirements which may apply in particular situations, determine the size and kind of dam to be built. Frequently preliminary designs and cost estimates of alternate types are necessary before sufficient information is available upon which to base the final choice.

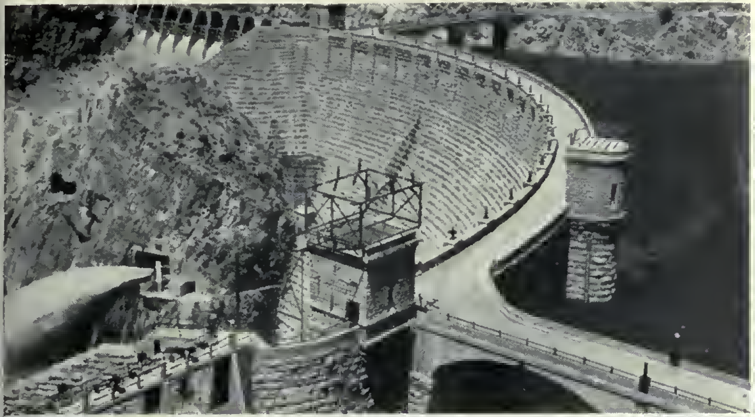
Consideration is given to the appearance of the dam and its incidental structures. The proper architectural treatment of large concrete dams to accord with their prominence, service, and surroundings is an important feature of their conception and construction. Much study and application of skill and ingenuity are required successfully to blend the functional and aesthetic qualities to achieve a harmonious, well-proportioned mass. Dams of lesser importance and interest, easily accessible from nearby centers of population, are made to present a pleasing appearance in conformance with the type of structure and surrounding terrain. The crests of earth dams are normally finished with a properly proportioned parapet wall. Appurtenant features, such as power-plant buildings, spillway and outlet structures, are made to harmonize with the architectural treatment given the dam.

Since its organization in 1902, the Bureau of Reclamation has completed a total of 148 dams in various locations in 15 Western States. Of this number, 59 have been for stream diversion and 89 for storage. This completed construction represents a total vol-

Architect's drawing, Grand Coulee Dam

Architect's drawing, Shasta Dam

THE SHASTA DAM AND POWER PLANT



Top: Roosevelt Dam, Salt River project, Arizona
Center: Stoney Gorge Dam, Orland project, California
Bottom: Imperial Dam, All-American Canal, Arizona-California

Upper: Alcove Dam, Kendrick project, Wyoming
Lower: Boulder Dam, Boulder Canyon project, Arizona-Nevada

ume of about 15,000,000 cubic yards of masonry and concrete and nearly 32,000,000 cubic yards of earth and rock-fill embankment. The total available storage provided is approximately 48,000,000 acre-feet. This total will be increased in the near future when Grand Coulee Dam in Washington is completed. It will have a volume of about 10,250,000 cubic yards of concrete and will form a reservoir of 9,800,000 acre-feet. Friant and Shasta Dams, now under construction on the Central Valley project in California, will require 1,905,800 and 5,400,000 cubic yards of concrete and will provide storage capacities of 512,500 and 4,500,000 acre-feet of water respectively. Deer Creek Dam in Utah and Green Mountain Dam in Colorado, also under construction, are earth fills of estimated embankment volumes of 3,000,000 and 4,456,000 cubic yards respectively. Their reservoir storage capacities will be 150,000 and 152,000 acre-feet, respectively. Four other major storage dams are under construction and a number of concrete and earth dams have been authorized for future construction and are in the process of design.

Of the 148 constructed dams, 69 are masonry or concrete structures, 68 are earth- and rock-fill, and 11 are rock-crib. The concrete dams include, with both overflow and nonoverflow sections, 11 arch, 12 gravity, 8 arch-gravity, 5 multiple-arch, 4 slab-and-buttress, and 29 diversion weirs of varying height and section. A brief description of major structures of various types follows: Boulder Dam, the highest dam in the world, of which much has been written, is an arch-gravity type with a height of 726.4 feet above the lowest point in its foundation, a crest length of 1,244 feet, and a total volume of concrete of 3,250,000 cubic yards. Grand Coulee Dam, now under construction across the Columbia River in the State of Washington, is a gravity dam that, when completed, will be the most massive masonry structure in the world, with a height of 550 feet and a crest length of 4,500 feet. Shasta Dam, now being built on the Sacramento River in California, also a gravity type, will have the highest overflow section ever constructed. This structure will have a maximum height of about 560 feet and a crest length of 3,500 feet. Noteworthy arch dams are the 295-foot-high Seminoe Dam, with a crest length of 525 feet, and the 328-foot Shoshone Dam, with a crest length of 200 feet. Both of these structures are located in the State of Wyoming.

Canals

RECLAMATION of arid lands is achieved, of course, only after water actually is delivered to the land for the production of crops. Application of the water to the land and the production of crops is the function of the farmer, but the delivery of water to the land is a function of the reclamation agency.

Delivery to the land involves three principal operations: diversion, conveyance, and distribution, each requiring the construction of distinct types of work, although those for conveyance and distribution often merge into each other.

Diversion works range from simple headworks set in the bank of a stream without any dam or training works, to elaborate structures including diversion dams with movable crests, fish ladders and highway crossings and headworks with power operated gates and power operated fish screens.

The Roza Diversion Dam, Roza Division, Yakima Project, is an excellent example of the complicated diversion structure. This structure raises the water surface in the river about 30 feet and diverts it into the Yakima Ridge Canal through a headworks structure provided with a radial gate 28 feet wide and 15 feet high and a motor-operated gate hoist. In front of the gate there are 6 motor-operated, circular, revolving fish screens each 20 feet wide and 13 feet 1 inch high. Trashracks are provided in front of the screens and a travelling gantry crane is installed for servicing the screens. The dam is a monolithic modified ogee gravity section on the crest of which there are two drum gates, each 110 feet long by 14 feet in diameter. These gates are so constructed that they may be raised clear of the concrete crest or lowered below the normal operating level to facilitate the passage of ice or floating debris. An elaborate fish ladder is also provided, as the Yakima River is of considerable importance as a salmon breeding stream.

Conveyance works include canals, tunnels, pipe lines, flumes, and incidental structures. Canals may be channels excavated in earth or rock with earth embankments following a grade contour along a hillside or located on a valley floor. Canals may also be lined with concrete or with clay or other impervious material. The Bureau has built 20,101 miles of canals, ditches, and drains, 81.8 miles of tunnels, 6,337 flumes, and 198,521 other irrigation structures.

The All-American Canal in southern California is by far the largest irrigation canal constructed in the United States. The Coachella Canal, diverting from the All-American, 36 miles from its head, is under construction and when completed will have a total length of 130 miles.

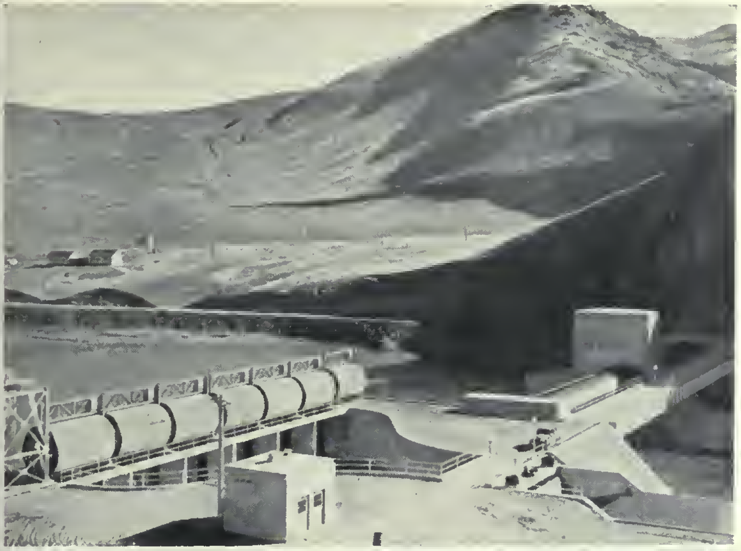
Tunnels are provided where their use will eliminate a sufficient length of canal to compensate for their greater cost or where their use will furnish a safe substitute for hazardous construction on a steep or unstable contour location. Tunnels are usually of the conventional horseshoe section, lined with concrete. Pipe lines are usually provided for crossing deep depressions or drainage courses where they operate as inverted siphons.

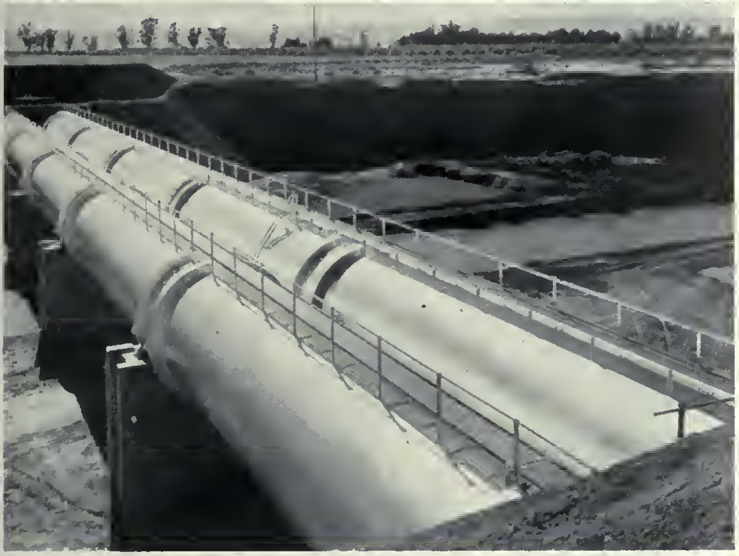
Flumes may be either of concrete or metal and may cross shallow depressions on piers or bents or may be placed directly on an excavated bench where conditions are not suitable for an open contour canal.

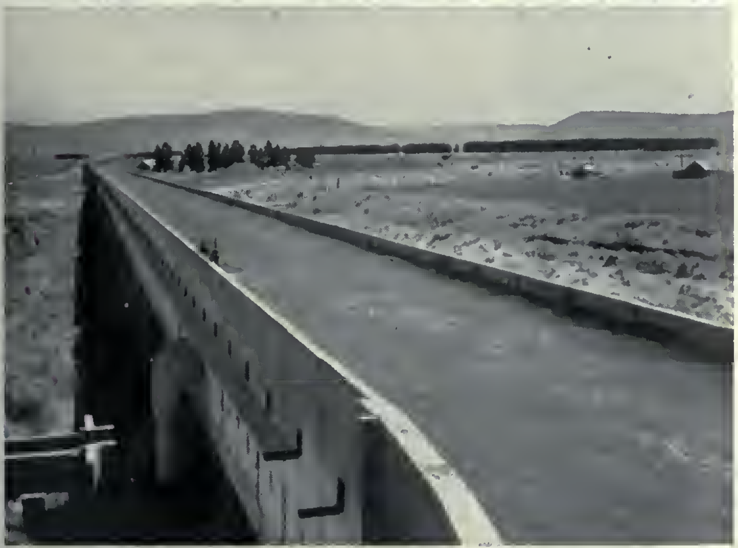
Incidental structures include diversion structures, turn-outs, checks, wasteways, spillways, bridges, cross drainage culverts, drainage overchutes, drainage inlets, and others. Individual designs vary with the hydraulic and structural requirements, and there is little uniformity in their structures.

Distribution works consist of laterals diverting from a principal conveyance conduit and of sublaterals diverting from a main lateral. Deliveries are usually made to each farm unit or to each legal subdivision the size of which is established for each project, and at an elevation which will permit the covering of the entire irrigable area of the land-holding served.

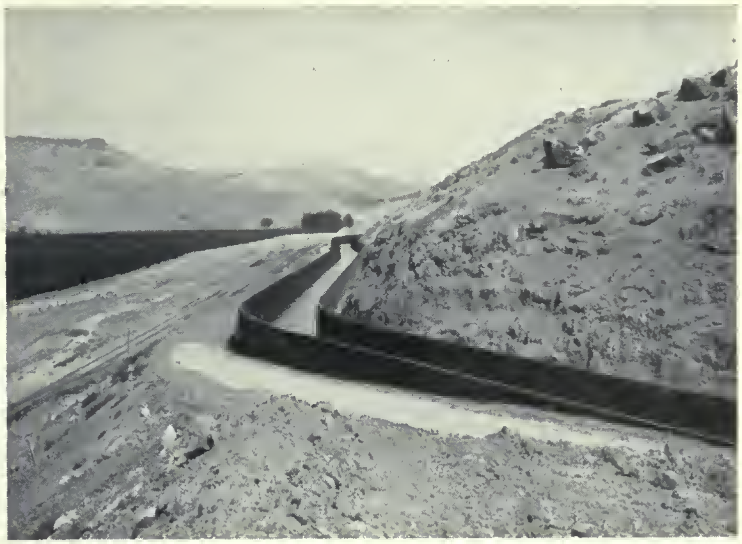
All-American Canal under construction

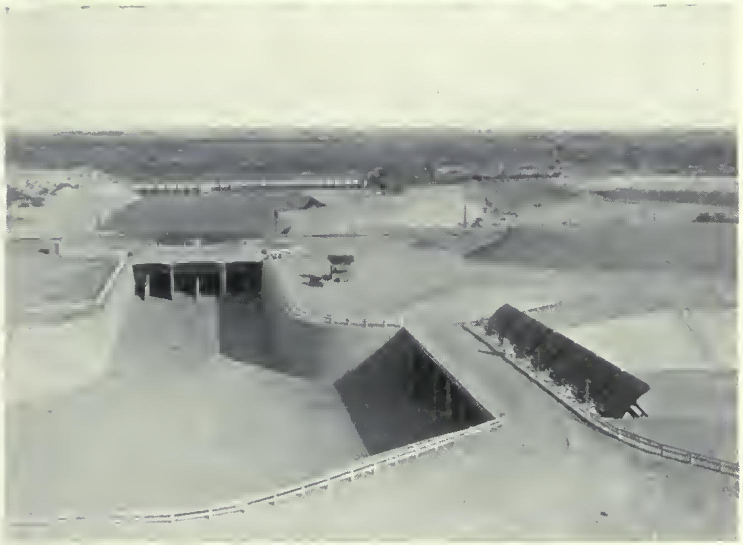


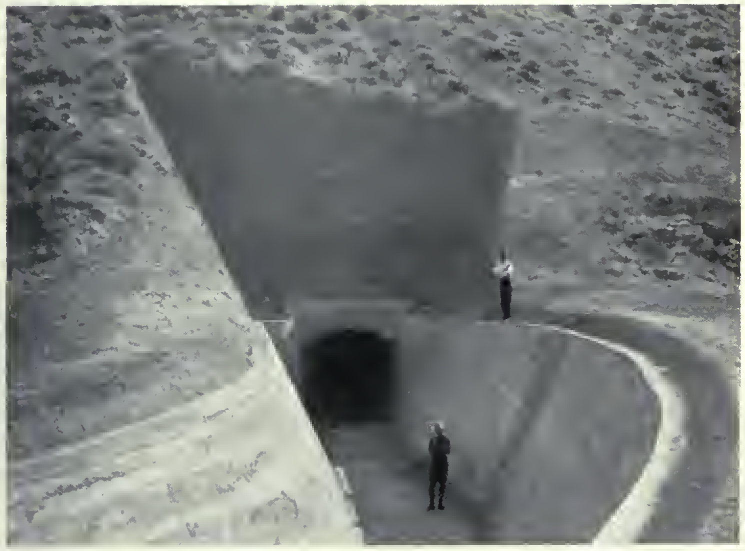




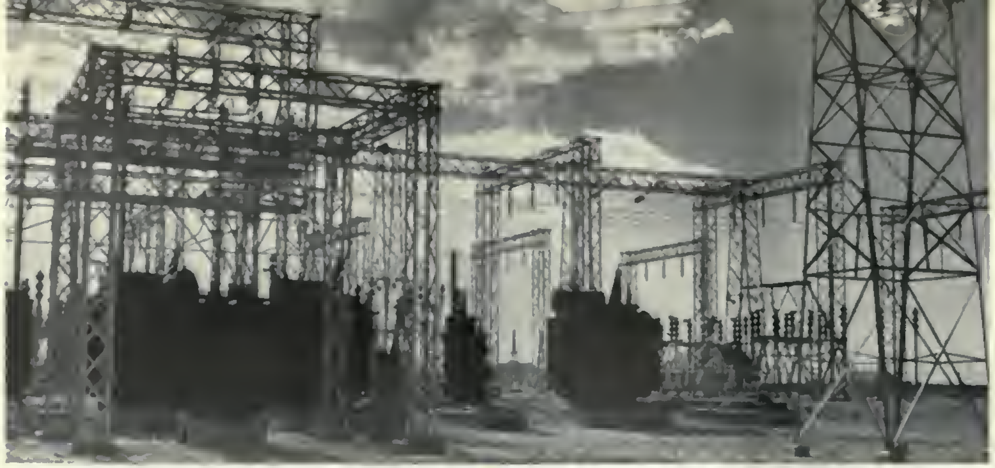
Top: Roza Diversion Dam, Yakima project, Washington
Center: New River Siphon, All-American Canal, Arizona-California
Bottom: Outlet on concrete flume C, Klamath project, Oregon-California







Top: Completed section of bench flume on Black Canyon Main Canal, Payette Division, Boise project, Idaho
Center: Pilot Knob check and wasteway, All-American Canal
Bottom: East Portal Tunnel, Uncompahgre project, Colorado



Power

THE development of hydroelectric power on projects engineered by the Bureau of Reclamation is incidental to the release of water from storage reservoirs, and to the utilization of drops in canals of the water distribution systems.

The power thus generated is used in part to pump irrigation water to areas that cannot be served by gravity canals, and for operation of project structures. The power surplus to these needs is sold on a wholesale basis, a preference in the right to buy being given to publicly owned utilities.

Descriptions of some of the 28 power plants which have been or are being constructed on Federal Reclamation projects follow.

The Elephant Butte power plant is located about 7 miles southeast of Hot Springs, N. M., on the Rio Grande. This plant is indicative of a special type of coordination for the generation of hydroelectric power and the meeting of exact requirements for the irrigation of agricultural lands. The Elephant Butte Reservoir stores a run-off of 2,274,000 acre-feet of water. The power installation of the Elephant Butte power plant consists of three 11,500-horsepower turbines rated at 257 revolutions per minute under the weighted average head of 140 feet and capable of developing 4,000 horsepower each under a minimum head of 73 feet. This plant will generate approximately 90,000,000 kilowatt hours annually with an estimated load factor of 60 percent. Before the installation of power facilities could be started, it was necessary that a regulating reservoir be provided downstream, and Caballo Dam was built approximately 7 miles below the Elephant Butte Reservoir. This reservoir has a live storage capacity of 360,000 acre-feet. This regulating reservoir enables the 3 turbines at Elephant Butte to carry loads in the most effective and efficient manner without regard to requirements for irrigation, since Caballo Reservoir provides re-regulation for irrigation. The power plant, completed in 1940, is located immediately below Elephant Butte Dam, which has been operating for nearly 24 years. The generating equipment consists of three 9,000-kilovolt amperes, 60-cycle, 6,900-volt, vertical shaft, synchronous water-wheel type generators, each having totally enclosed air housings with water-cooled heat exchangers. The effective head on the turbines has been increased approximately 10 feet by digging a channel in

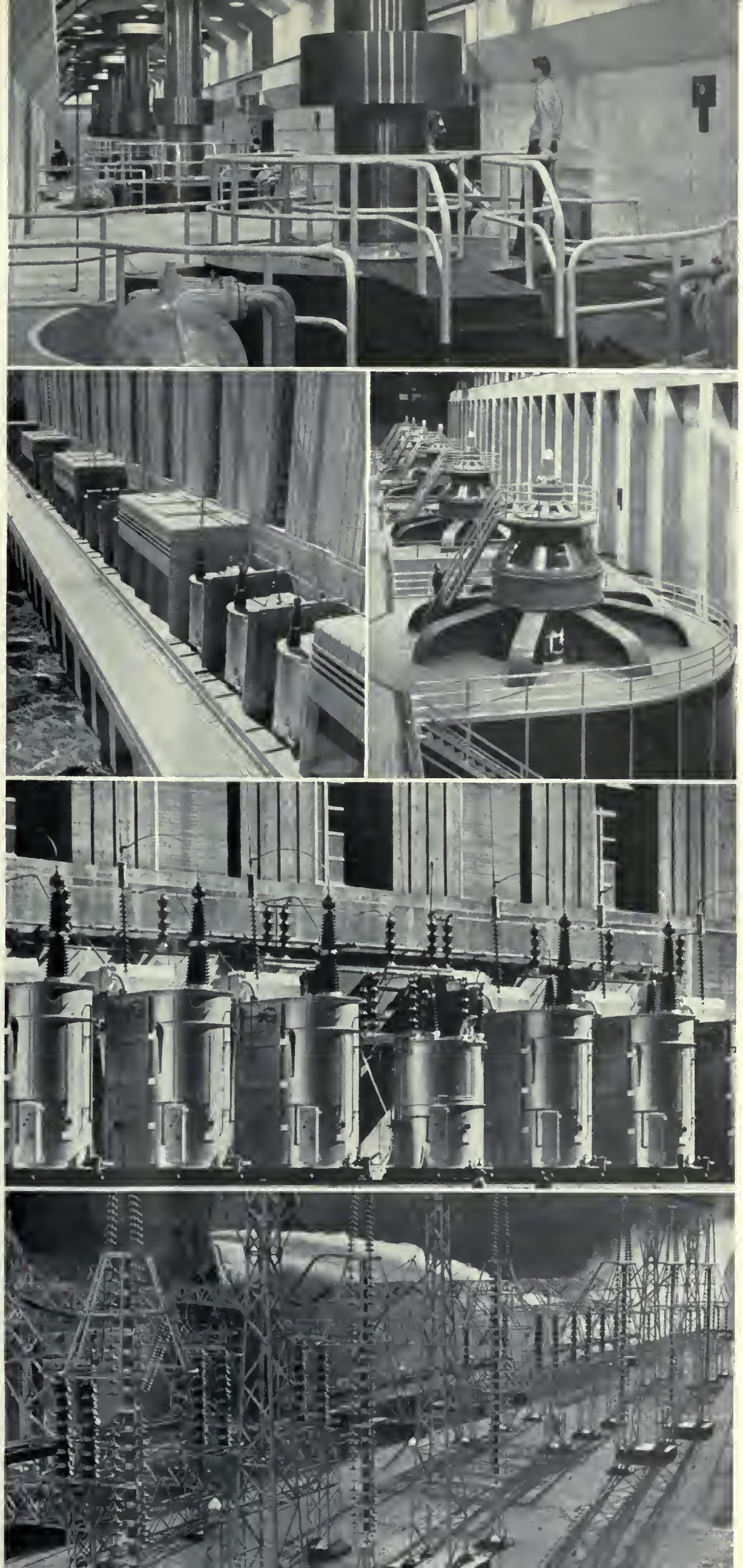
Top to bottom:

Greeley substation, Shasta Dam power project, Central Valley project, California

Power Drop No. 4, All-American Canal

Switchyard, Power Drop No. 4

Interior of Minidoka powerhouse, Minidoka project, Idaho



BOULDER DAM POWER PLANT

Top to bottom:
Nevada wing
Turbine gallery (*left*)
Generator gallery (*right*)
Transformers, Arizona wing
Take-off structures, Nevada wing

the sand of the existing river bed for a distance of approximately 1½ miles below the power plant. For the greater part of the time all water released from the Elephant Butte Reservoir will be used for the generation of power. The amount of water spilled will be negligible.

The Seminoe power plant, located on the Kendrick project about 37 miles northeast of Parco, Wyo., is a part of Seminoe Dam, located on the North Platte River. This plant is typical of the type of medium-head lew-flow storage developments and consists of 3 units of 15,000 horsepower each at the rated head of 171 feet and three 12,000 kilovolt-ampere generators.

The Green Mountain power plant, located in Colorado, is the first unit to be constructed in the Colorado-Big Thompson transcontinental diversion project and consists of 2 units developing 15,000 horsepower, each under a rated head of 203 feet, and two 12,000 kilovolt-ampere generators. The head range at this plant is from a minimum of 122 to a maximum of 240 feet.

Typical of low-head propeller-type turbine installations at canal drops is the siphon drop plant at Yuma, Ariz., with two 1,160 horsepower units, each operating under a 14-foot head. Plants on the All-American Canal designated as drops Nos. 3 and 4, owned and operated by the Imperial Irrigation District, will have a combined installation of 41,600 horsepower utilizing the change in elevation of the water surface in the canal. These developments are strictly byproducts from the flow of irrigation water and are constructed at exceptionally low unit costs.

Typical of power developments at low-head secondary regulating reservoirs below principal storage projects is the Minidoka power plant at Lake Walcott on the Snake River in Idaho. This is one of the earlier developments engineered by the Bureau of Reclamation and has a capacity of 13,400 kilowatts. The head on the plant, approximately constant at 48 feet throughout the year, is created by water release from the American Falls Reservoir.

The latest and most important power development of the type described for Minidoka is at Parker Dam, Ariz., utilizing water released from Lake Mead, formed by Boulder Dam. The power plant now under construction will accommodate four units of 40,000 horsepower each when operating at a substantially constant head of 80 feet. These units are of the Francis type with plate-steel spiral casings.

Boulder Power Plant

The power plant at Boulder Dam, the largest now operating in the world, is located where the Colorado River forms the boundary between Nevada and Arizona. Lake Mead, created by Boulder Dam, impounds water from 170,000 square miles of drainage area, and has a storage capacity of 30,500,000 acre-feet, about one-eighth of which is dead storage. This makes possible the reduction of maximum floods past the dam site from 250,000 to 75,000 cubic feet per second and the raising of the minimum flow from 2,300 to 8,000 cubic feet per second. The power plant turbines must operate satisfactorily under extreme effective head variations from 420 feet to 590 feet. However, the effective head under normal conditions averages about 530 feet 90 percent of the time. The power plant is located at the toe of the dam, forming a U-shaped structure with its base at the dam and its wings extending downstream on each side of the river. The main generating units, consisting of vertical-shaft, single-runner, Francis-type turbines with cast-steel spiral casings, connected to suitable alternating-current generators, will be installed in the wings of the power plant, eight 115,000-horsepower units in the Nevada wing and seven 115,000 and two 55,000-horsepower units in the Arizona wing. The base of the U contains two station service units, sump pumps, machine shop, control and auxiliary equipment. Each station service unit consists of a horizontal shaft, double-overhung, impulse turbine with a rating of 3,500 horsepower connected to a 3,000-kilovolt-ampere, 60-cycle, 3-phase 2,400-volt, 300-revolution-per-minute generator. All of the large main generators will operate at 60 cycles, 180 revolutions per minute and are rated at 82,500-kilovolt-amperes and 16,500 volts, except two in the Arizona wing which can operate interchangeably at 50 or 60 cycles without taking the unit out of service. The two smaller generators in the Arizona wing are rated at 40,000 kilovolt-amperes, 60 cycles, 257½ revolutions per minute and 13,800 volts. The present installation includes 6 of the large units in the Nevada wing and two of the large and one of the small units in the Arizona wing. Other units are being manufactured and the installation will be made as required to meet the demands of power lessees. The powerhouse roof is approximately 4½ feet in thickness and is designed to withstand the impact of large boulders which may fall from the walls of the canyon. The power is transformed to 287,000 volts for transmission by banks of three 55,000-kilovolt-ampere transformers, located on the deck on the river side of the power plant. It is carried to switching structures on the powerhouse roofs and then almost vertically over the canyon rim to main switching stations for transmission largely to southern California, a distance of about 265 miles.

The power plant at the base of Shasta Dam will be located about 9 miles north of Redding, Calif., on the Sacramento River. The dam and power plant now are under construction. The reservoir, when full, with surface elevation 1,065 feet above sea level, will cover an area of about 30,000 acres, with storage capacity of 4,500,000 acre-feet. Normally, the reservoir will be operated only partly full, with surface elevation 1,000, leaving a capacity of 1,780,000 acre-feet for use in controlling floods. Irrigation at times may draw the lake down to a surface elevation of 828 feet above sea level. With the reservoir surface elevation varying, reaching a maximum of 237 feet, the turbines must operate under effective heads ranging from 238 feet at low water to 475 feet at flood stage; with the point of maximum efficiency coming at the normal reservoir, producing an effective head of 408 feet. It is expected that an effective head in excess of 366 feet will be provided at least 75 percent of the time. Shasta power plant is designed to accommodate five 103,000-horsepower units, consisting of vertical-shaft, single-runner, Francis-type turbines with spiral casings, together with 3-phase, 60-cycle, 138½-revolution-per-minute, 13-800-volt alternating-current generators. Station service requirements will be met by 2 small units, consisting of 3,500-horsepower, 600-revolutions-per-minute, vertical-shaft, single-runner, Francis-type turbines connecting with 2,500-kilovolt-ampere 2,400-volt, 60-cycle, alternating-current generators. The dam and powerhouse will be connected by means of five exposed, welded plate-steel penstocks, about 830 feet in length and varying in diameter from 15 feet 3 inches at the intake to 11 feet 6 inches at the downstream end, one for each main unit. Water for the 2 station service units will be obtained through a flexible valve arrangement from the main penstocks. River outlet works, bypassing water around the turbines, are to be embedded in the spillway section of the dam. Three transformers per unit, each with a rating of 25,000 kilovolt-amperes, are located on the deck on the downstream face of the powerhouse.

Grand Coulee Power Plant

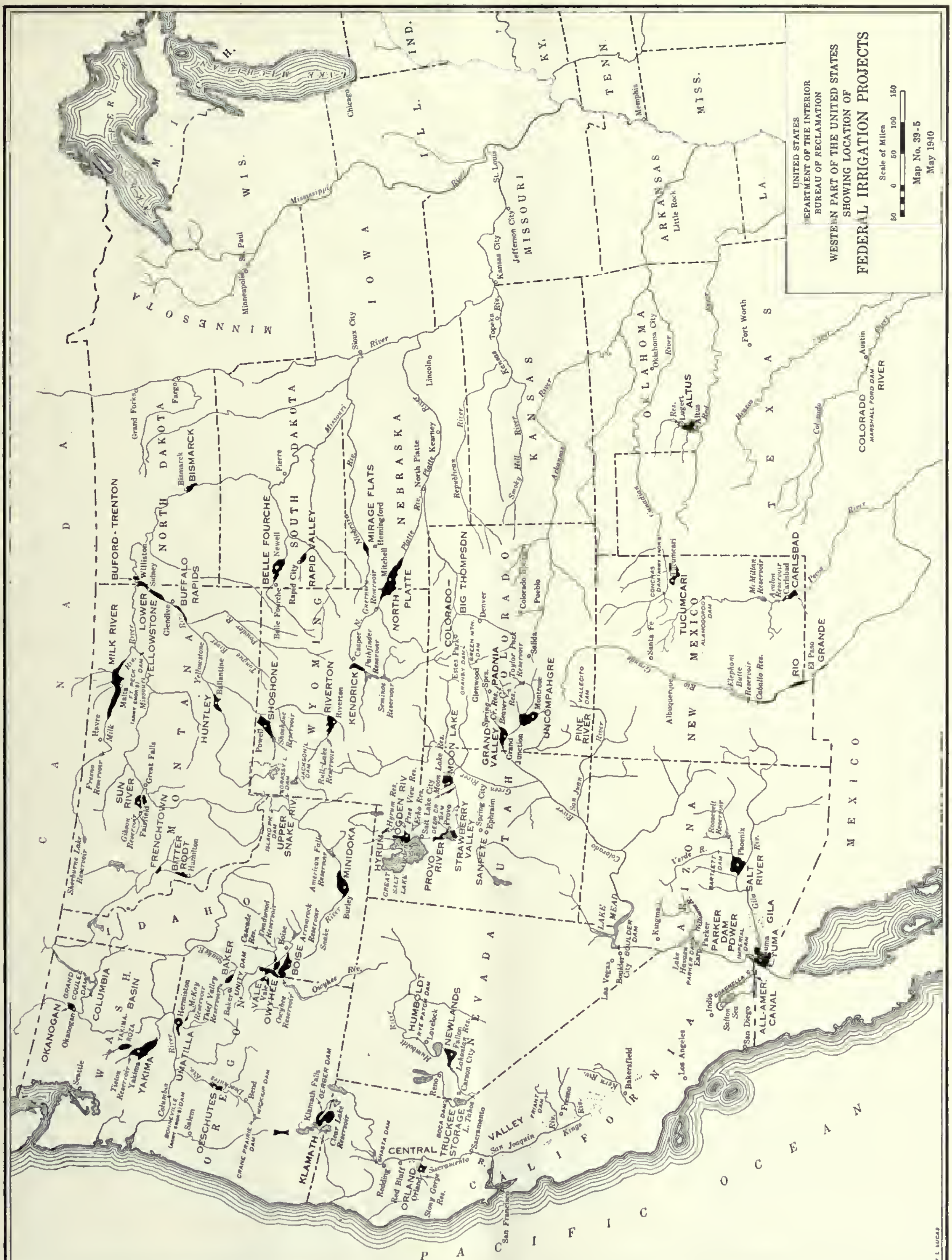
The Grand Coulee Dam and power plant now under construction make up the first unit of the vast Columbia Basin project. The reservoir, of a maximum length of 151 miles, will impound 10,000,000 acre-feet of water. The upper 80 feet of the reservoir, containing about 5,000,000 acre-feet, will be available for use in power generation and for regulating the river flow downstream. Part of the secondary power generated will be used during high water seasons to pump water into a balancing reservoir in the Grand Coulee where by means of a system of canals and laterals it will be distributed for irrigation purposes to about 1,200,000 acres of fertile but dry lands. The maximum flow at the dam site is 492,000 cubic feet per second and the minimum is about 20,000 cubic feet per second with an average flow of 109,000 cubic feet per second. The average amount of electrical energy available each year is estimated at 12,520,000,000 kilowatt-hours of which 8,320,000,000 kilowatt-hours is firm energy and 4,200,000,000 kilowatt-hours is secondary energy. A maximum of 2,260,000,000 kilowatt-hours of this secondary energy will be used for pumping for irrigation. The power plant located on the toe of the dam consists of two powerhouses, one at each end of the dam. Each building is designed for the ultimate installation of nine 150,000-horsepower turbines driving 60-cycle main generators of 108,000 kilovolt-ampere capacity each and in addition the left powerhouse provides space for three 14,000-horsepower turbines driving 60-cycle service generators of 12,500 kilovolt-amperes each, and for a control bay. The control bay will contain a machine shop, control room, offices, and general station service facilities. The power from 6 of the 150,000-horsepower units will be used for operating 12 65,000-horsepower pumping units in the Grand Coulee pumping plant which forms the left abutment of the main dam. The initial development includes the completion of the left powerhouse and the installation of three 150,000-horsepower main units, two 14,000-horsepower station service units and common station facilities. The turbines are of the Francis-type with single-vertical-runner and with respect to horsepower capacity are the largest hydraulic prime movers in existence. The center lines of the turbine distributors are set at elevation 938.0 so that the tail water surfaces will vary from about 60 feet above to 6 feet below the center line of the turbines, the average being from 5 to 10 feet above it. The turbines will operate under a net effective head varying from a minimum of 265 feet to a maximum of 355 feet but for 90 percent of the time the weighted average net head is 330 feet. The powerhouse is of reinforced concrete construction with steel trusses. The downstream wall is of box girder design heavily reinforced to take the pressure of tail water to a maximum possible elevation at flood stage of 1,020.

New Maps Available

A NEW MAP of the Main Power Transmission Lines in Western United States and one of the Central Valley Project, California, have been issued by the Bureau of Reclamation and may be obtained upon application to the Bureau, payment to be made in advance by check or money order drawn to the Bureau of Reclamation. POSTAGE STAMPS ARE NOT ACCEPTABLE. These maps are described as follows:

Main Power Transmission Lines in Western United States. Map No. 40-7 (1940); size 22 by 23 inches; price, 25 cents each.

Central Valley Project, California. Map No. 40-14 (1940); colored; size 15 by 21½ inches; price, 25 cents each.


UNITED STATES
DEPARTMENT OF THE INTERIOR
BUREAU OF RECLAMATION
WESTERN PART OF THE UNITED STATES
SHOWING LOCATION OF
FEDERAL IRRIGATION PROJECTS
Scale of Miles
50 0 50 100 150
Map No. 39-5
May 1940
OKANOGAN
YAKIMA
COLUMBIA BASIN
UMATILLA
DESCHUTES
KLAMATH
ORLAND
CENTRAL VALLEY
TRUCKEE STORAGE
NEWLANDS
HUMBOLDT
OWYHEE
VALE
BAKER
BOISE
MINIDOKA
UPPER SNAKE RIV
BITTER ROOT
FRENCHTOWN
SUN RIVER
MILK RIVER
LOWER YELLOWSTONE
BUFORD-TRENTON
BUFFALO RAPIDS
HUNTLEY
SHOSHONE
RIVERTON
KENDRICK
BELLE FOURCHE
RAPID VALLEY
BISMARCK
MIRAGE FLATS
NORTH PLATTE
COLORADO-BIG THOMPSON
GRAND VALLEY
PAONIA
UNCOMPAHGRE
PINE RIVER
MOON LAKE
HYRUM
OGDEN RIV
PROVO RIVER
STRAWBERRY VALLEY
SANPETE
LAKE MEAD
BOULDER DAM
PARKER DAM POWER
SALT RIVER
GILA
YUMA
ALL-AMER. CANAL
RIO GRANDE
CARLSBAD
TUCUMCARI
ALTUS
COLORADO RIVER
CANADA
MEXICO
PACIFIC OCEAN
WASH.
OREGON
CALIFORNIA
NEVADA
IDAHO
MONTANA
WYOMING
UTAH
ARIZONA
COLORADO
NEW MEXICO
NORTH DAKOTA
SOUTH DAKOTA
NEBRASKA
KANSAS
OKLAHOMA
TEXAS
MINNESOTA
IOWA
MISSOURI
ARKANSAS
WIS.
ILL.
IND.
KY.
TENN.
MISS.
LA.
W. T. LUCAS

Transmission Lines

TRANSMISSION lines sometimes form an important part of project construction when the project includes power development. The increase in the number of large multiple-purpose projects in which power generation figures as a major element, has in recent years brought about an increase in the amount of transmission line construction by the Bureau.

By the fall of 1940 the Bureau will have 1,550 miles of 60-cycle, 3-phase transmission lines in operation. The voltages of these lines range from 33,000 to 154,000 volts, and wood-pole construction has been used throughout. These lines are constructed in 11 Western States and are on 15 of the Bureau's reclamation projects. The terrain over which these transmission lines are constructed varies from the roughest Colorado Rocky Mountain districts to the plains of Wyoming and the desert of Arizona. Customers served include REA developments, municipally owned systems, or public utility companies which in turn distribute the power to the individual consumer. The Bureau does not enter into retail power sales except within its own Government-operated camps.

A typical installation of 33,000-volt, 2,000-kilovolt-ampere line is the one constructed from the Pilot Butte plant near Riverton to Thermopolis, Wyo., a distance of 50 miles, where it then interconnects with the Mountain States Power Co. system. A 66,000-volt, 21,600-kilovolt-ampere line from the Green Mountain power plant in Colorado is now under construction to the west portal of the Colorado-Big Thompson project's diversion tunnel near Grand Lake, Colo., a distance of 50 miles. This line will serve Kremmling, Hot Springs, and Granby, Colo. A 110,000-volt, 32,400-kilovolt-ampere line is in operation from the Seminoe power plant to Cheyenne, Wyo., a distance of 143 miles. A continuation of this line operates to Greeley, Colo., a distance of 53 miles, where it interconnects with the network of the Public Service Co. of Colorado. This line, recently extended an additional 70 miles east, will serve the city of Fort Morgan, Colo., and the new REA developments at Wiggins and Brush, Colo. A 154,000-volt, 80,000-kilovolt-ampere line has been built from Parker Dam power plant to Phoenix, Ariz., a distance of 135 miles. It is serving the Salt River Valley Water Users Association with power now being obtained from Boulder Dam over the lines of the Metropolitan Water District of southern California. This connection has served to alleviate a serious power shortage in central Arizona growing out of drought in the watershed of the Salt River. When the Parker Dam plant has been installed, this line will serve other utilities in central Arizona as well.

All transmission lines have been designed in the Denver office of the Bureau of Reclamation. Stability and corona studies are made on each new prospective line to determine the economic voltage and conductor size. In specific cases, when it is proposed to connect a Bureau line into an established transmission network, calculating board studies have been made to determine the most satisfactory line characteristics. In general, all design, line construction, and ground clearances are made to conform to the National Safety Code, issued by the United States Bureau of Standards.

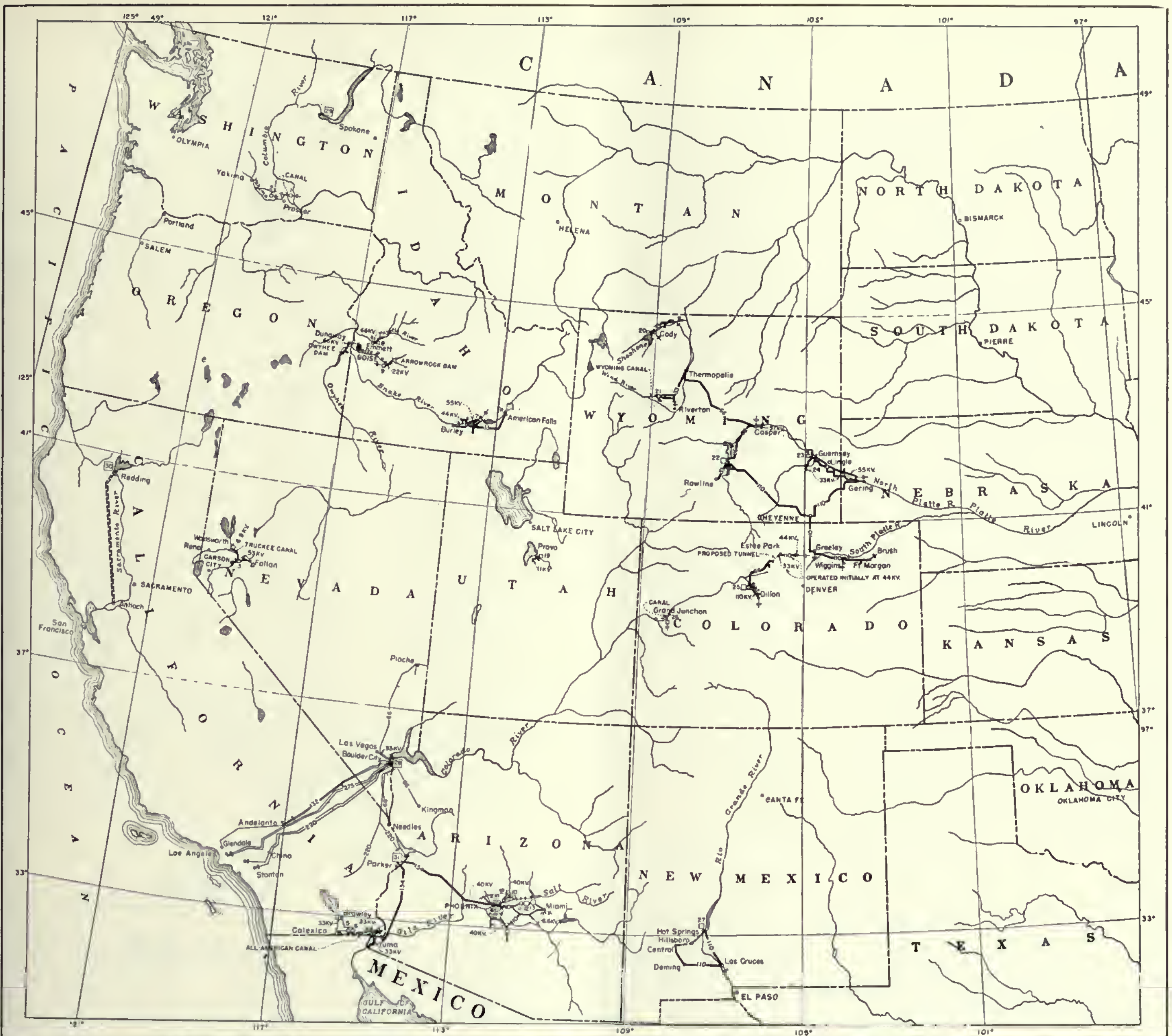
In the design of its transmission lines, the Bureau endeavors to utilize as much of the available wood insulation between phase conductors as possible. In the recent design of the 33,000- and 44,000-volt transmission lines a triangular configuration of conductors has been adopted. Wood cross-arm braces are used and the cross-arm hardware is not grounded. To raise further the electrical impulse strength of the structure and thereby decrease the lightning hazard, wood-strain guy insulators are installed in all guys. This type of construction tends to produce the effect of a floating line and has been found very effective in decreasing outages from lightning. The 66,000-, 110,000-, and 154,000-volt lines of the Bureau have all been constructed of the wood-pole, H-frame type, using two cross arms mounted parallel to each other and separated with steel hardware. The average span of the H-frame type lines has been between 600 and 675 feet, depending on the type of conductor. The lines have been constructed of suspension-type structures, dead-end tension structures used only at points of conductor uplift or long spans. Wood X-braces have been installed on a number of H-frame structures for rigidity, and sectionalizing switches have been constructed in the lines at suitable points. Wherever practical, ground-fault neutralizers have been installed at the substations for lightning protection of the transmission lines. This method of protection requires that the transmission line structures have a high electrical impulse strength between the phase conductors. The structure hardware, therefore, is not grounded and advantage is taken of the wood insulation. Each structure is grounded by a ground wire which is stapled to each pole for its full length and wrapped around the butt end of the pole. Overhead ground wires have not been installed on the present 66,000-volt nor on the 110,000-volt lines. The 154,000-volt line recently completed between Parker Dam and Phoenix, Ariz., has 2 overhead ground wires and is further protected with the installation of a continuous copper counterpoise buried approximately 2 feet underground and connected to the structure ground system at each structure.

In providing means for disposal of the power generated at the various power plants of the Bureau it has been necessary to design and install substations ranging from a simply designed 100-kilovolt-ampere station for supply to a small municipality to the 500,000 kilovolt-ampere switching station feeding the three 287-kilovolt transmission lines of the city of Los Angeles at Boulder Dam.

The Bureau provides the necessary facilities for connection to the transmission or distribution equipment of the wholesale customers, who have quite a wide range of requirements. The switching and transforming facilities which the Bureau has been called upon to supply may be divided into five general groups:

1. *The high voltage switching station* connecting to the transmission lines of the customer or to the lines of the Bureau itself. Examples of this type are the 287-kilovolt switchyard for the city of Los Angeles, the 230-kilovolt switchyards for the Metropolitan Water District and the Southern California Edison Co. and the 138-kilovolt switchyard for the Nevada-California Power Co. at Boulder Dam.
2. *The high voltage step-down substation.* The capacities of transformers used at substations of this type vary through a wide range, and in some instances, the high voltage switching facilities of the first type are combined with this type, as at the Cheyenne substation of the Kendrick project. These stations usually constitute interconnections between the transmission system of the Bureau and private utility systems.
3. *The distribution substation* of the Bureau is usually built for a single customer, such as a municipality or REA district to whom the distribution system belongs. Usually no interconnection is involved in this type. Present REA activity has resulted in the building of many such stations. Fort Morgan and Wiggins substations are typical illustrations of this type.
4. *Pumping plant transformer stations* are necessary on all irrigation projects requiring pumping and may take their power from either the transmission lines of the Bureau or from those of private utilities. The Bureau has a relatively large number of such stations, which are standardized to the extent which local conditions will permit. Glendive transformer station is one of a fairly recent design.
5. *Temporary construction substations* are needed wherever construction power is furnished by the Bureau to the contractor or to its own field forces. In some cases, the construction substation later becomes the permanent installation for outgoing power. In all cases where the installation is known to be temporary, conservatively designed wood structures are used with steel and concrete for the permanent jobs. Green Mountain construction substation is a typical example of the temporary type.

Step-down transformer capacity, now operating or to be installed in Bureau substations totals approximately 218,000 kilovolt-amperes, which is exclusive of all Bureau pumping plant transformer stations. Present and definitely planned synchronous condenser installations total 60,000 kilovolt-amperes.



	DATA ON POWER PLANTS					
No	NAME	PROJECT	NEAR TOWN OF	MAIN UNITS CAPACITIES (KW)		No. UNITS ULT.
				PRESENT	ULTIMATE	
1	Prosser	Yakima	Prosser, Wash.	2400	2400	1
2	Rocky Ford	Yakima	Grandview, Wash.	150	150	1
3	Lahontan	Newlands	Lahontan, Nev	1500	1500	3
4	Siphon Drop	Yuma	Yuma, Ariz	1600	1600	2
• 5	Drop No 4	Imperial Valley	Calexico, Calif	9600	19200	2
• 6	Drop No. 3	Imperial Valley	Calexico, Calif.	4800	9600	2
7	Minidoka	Minidoka	Rupert, Idaho	8400	13400	7
8	Black Canyon	Boise	Emmett, Idaho	8000	8000	2
9	Boise River	Boise	Boise, Idaho	1500	1500	3
10	Stewart Mountain	Salt River	Phoenix, Ariz.	10400	10400	1
11	Mormon Flats	Salt River	Phoenix, Ariz.	7000	7000	1
12	Horse Mesa	Salt River	Phoenix, Ariz.	30000	30000	3
13	Roosevelt	Salt River	Globe, Ariz.	15400	15400	7
14	Arizona Falls	Salt River	Scottsdale, Ariz	850	850	2
15	Chandler	Salt River	Mesa, Ariz.	600	600	1
16	South Consolidated	Salt River	Lehi, Ariz	1600	1600	2
17	Diesel, Salt River	Salt River	Tempe, Ariz.	10000	10000	2
18	Crosscut	Salt River	Tempe, Ariz	5100	5100	4
19	Spanish Fork	Strawberry Valley	Spanish Fork, Utah	1150	1150	3
20	Shoshone	Shoshone	Cody, Wyo	5600	5600	3
21	Pilot Butte	Riverton	Pavalion, Wyo.	1600	1600	2
22	Seminoe	Kendrick	Parco, Wyo.	32400	32400	3
23	Guernsey	North Platte	Guernsey, Wyo.	4800	4800	2
24	Lingle	North Platte	Lingle, Wyo.	1400	1400	4
• 25	Green Mountain	Colo. Big Thompson	Kremmling, Colo.	21600	21600	2
• 26	Grand Valley	Grand Valley	Palisade, Colo.	3000	3000	2
• 27	Elephant Butte	Rio Grande	Hot Springs, N.M.	24300	24300	3
28	Boulder	Boulder Canyon	Boulder City, Nev	865000	1317500	17
• 29	Grand Coulee	Columbia Basin	Coulee Dam, Wash.	324000	1944000	18
• 30	Shasta	Central Valley	Redding, Calif.	300000	375000	5
• 31	Parker	Parker Dam Power	Earp, Calif.	90000	120000	4
	• Power plants under construction or authorized for construction.					

EXPLANATION

□ Hydro-electric plant 100 000 kilowatt or over.
▫ Hydro-electric plant 15000 to 99999 kilowatt.
▫ Hydro-electric plant 14999 or less.
◘ Fuel plant 14999 or less.
┼ Interconnection with privately owned lines.
━ Lines owned and operated by the Government.
— Lines owned by the Government and operated by water users or private companies
— Lines owned and operated by private companies. Shown only where they are of major importance.
┼ Transition between lines of different voltages.
—110— Example of indication of voltage of line.
Dam on river or drop structure on canal. Shown at power projects only

50 0 100 200 300
SCALE OF MILES

UNITED STATES
DEPARTMENT OF THE INTERIOR
BUREAU OF RECLAMATION

GENERAL MAP
SHOWING
LOCATION OF POWER DEVELOPMENTS
BUREAU OF RECLAMATION PROJECTS

Pumping

GRAVITY will not always carry irrigation water to the lands to be served, and pumping has been resorted to for both large and small irrigation systems. Pumps are used also in disposal of collected drainage water in many instances.

Pumping plants constructed for irrigation and drainage purposes may be divided into four classes.

1. Individual pumping plants installed on farms for irrigation of the farmstead by water pumped from wells.

2. Pumping plants which are located at a source of water to lift the water to receiving reservoirs or for discharge directly into distribution systems.

3. Pumping plants which function as a part of a distribution system serve to relift water along the main canals or to relift water from the main canals into secondary canals and laterals.

4. Pumping plants which are constructed for the purpose of pumping collected drainage water into adequate disposal channels.

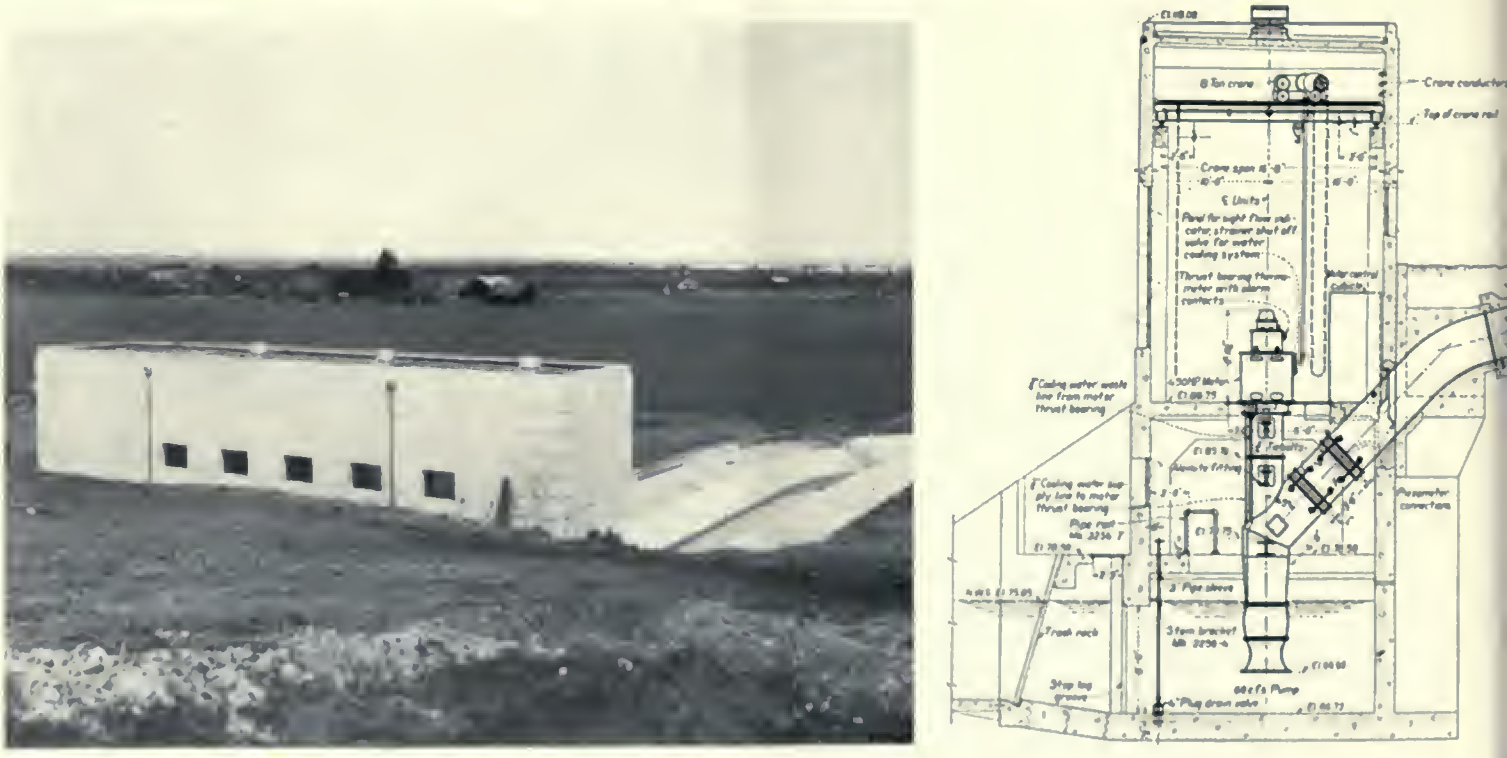
The Bureau of Reclamation has constructed pumping plants, both small and large, of the three classes last named. There are now installed 77 pumping plants having a total pumping capacity of 6,100 second-feet and operating at static lifts ranging from 1.5 to 200 feet. These installations comprise pumping units of both the vertical and horizontal types, driven by electric motors, hydraulic turbines, and oil and gas engines.

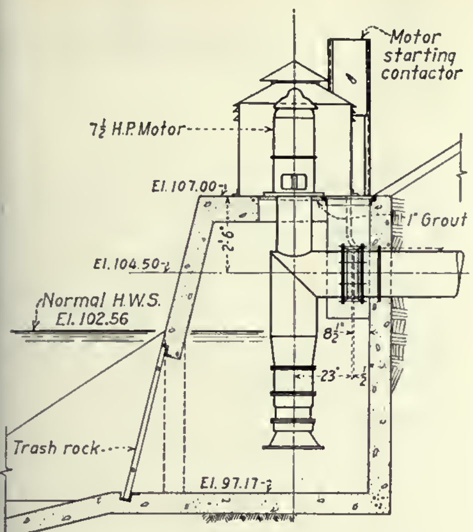
A typical example of a pumping plant located at a source of water, and lifting water directly into a gravity distribution system is the Glendive pumping plant in Montana. The pumping units are of the vertical, volute, centrifugal type, direct-connected to vertical synchronous motors having direct-connected exciters. The plant consists of two units with provision for an additional unit. Each pump unit has a capacity of 110 second-feet when operating at a total head of 103 feet. Each pump has a separate intake tube formed of concrete with trashracks and stop logs provided at the entrance. The pumps operate under 4 feet of suction lift. Each pump discharges into a common 84-inch diameter monolithic-concrete discharge pipe line 725 feet in length. A motor-operated gate valve is installed in the discharge of each pump so that priming of the pumps may be accomplished separately. This also serves to prevent the discharge water of an operating pump from short-circuiting through the idle pumps. The pumps and motors are designed to operate safely in reverse direction upon reversal of flow of water in the discharge line. The discharge pipe is provided with a flap valve and vent at its outlet at the canal.

Similar in class to the Glendive pumping plant are the Dead Ox, Owyhee Ditch, and Grand Coulee pumping plants. The Grand Coulee plant, when completed, will be the father of all pumping plants. This giant plant will have an ultimate installation of 12 ver- tical, motor-driven pumps of 1,600 second- feet capacity each, when operated at a lift varying from 295 to 320 feet. These pumps will lift 6,000,000 acre-feet of water annually from the reservoir of Grand Coulee Dam in the Columbia River for irrigation of Columbia Basin lands. The pumps will be operated during periods when there is an excess of water available in the reservoir for power generation.

The Contra Costa Canal pumping plants in California are typical of plants which func tion as a part of a distribution system. They are used to relift water at 4 points to highe levels along a canal, each plant handling th capacity of the canal through separate lift varying from 25 to 50.5 feet. The plant ultimately will have 6 units each, installe in wet pits. Each unit will consist of vertical, single-stage, submerged, modifie propeller-type pump direct-connected to ver tical, synchronous motors with direct connected exciters. The pumps discharg directly into a canal at the rear of the plants each discharge pipe being fitted with a fla valve. Upon shut-down of the pumps, th water in the discharge pipes returns throug the pump to the pump pit. In a series o relift plants, it is important that the plant keep in step and thus maintain constant flov and canal water level. These Contra Cost

Contra Costa Canal—Pumping Plant No. 4, Central Valley project, California


8 Ton crane
Crane conducto
Top of crane rail
Crane span
℄ Units
Panel for sight flow indicator, strainer shut off valve for water cooling system
Thrust bearing thermometer with alarm contacts
Motor control cubicle
℄ Cooling water waste line from motor thrust bearing
℄ Cooling water supply line to motor thrust bearing
Pipe rest
Piezometer connections
3" Pipe sleeve
Trash rack
Stem bracket
Stop log groove
60 c.f.s. Pump
Plug drain valve



Cross section, Wisteria Pump Turnout No. 2, All-American Canal

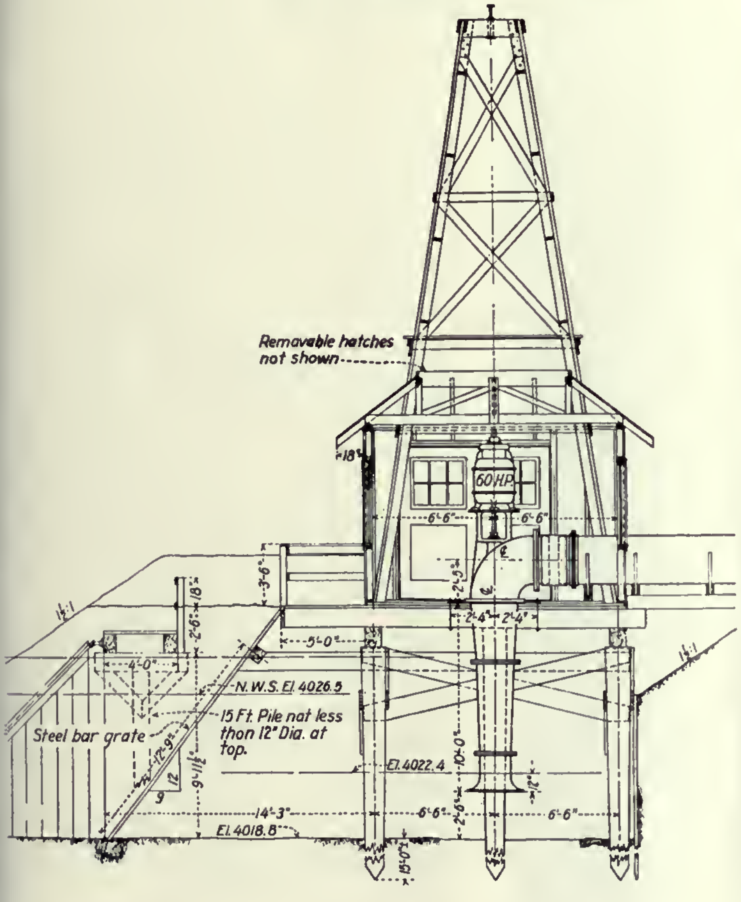
Canal plants regulate the flow and water level in the canal by automatic means and overflow weirs are provided on the discharge side of the plants to prevent overflow of the canal in the event of accidental shut-down of an upstream plant.

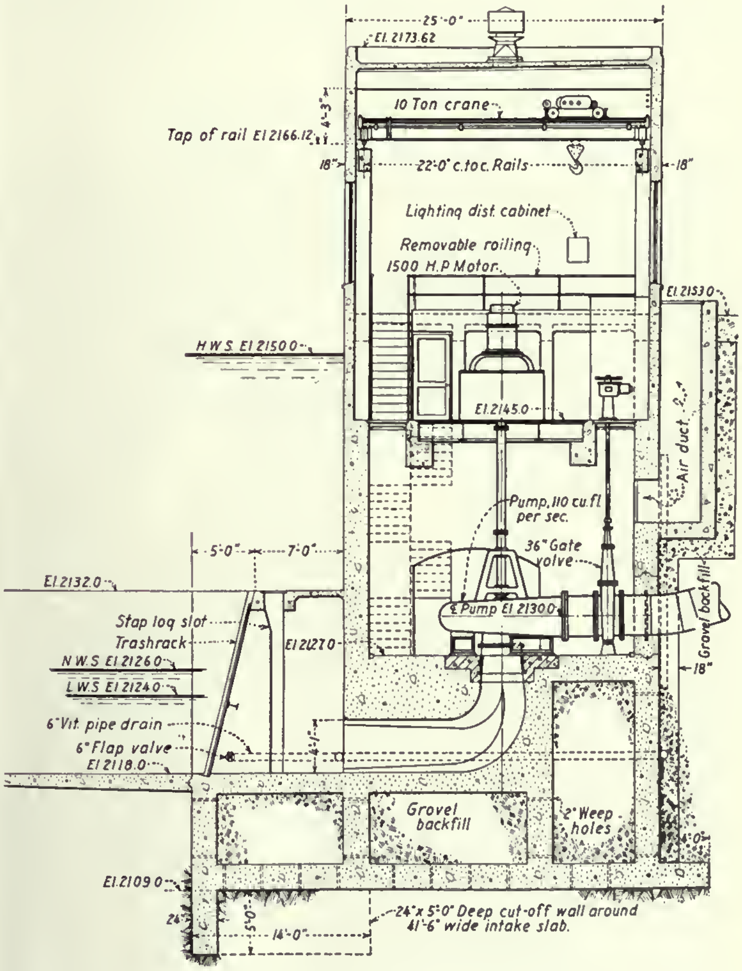
Small installations of relift pumps are often installed along main distribution canals. The MacNutt and Lindsey pump turn-out located on the All-American Canal system is a typical installation of low-lift pump for raising water from a canal to a lateral for irrigation purposes. This pumping unit is of the low-head, vertical-shaft, propeller type having a capacity of 9 second-feet when pumping against a head of 4 feet. The pump is direct-connected to a vertical, weatherproof, induction-type motor but because of its location in a region of extremely high temperatures, the motor is protected from the intense sun by a sheet-metal housing designed to provide ample ventilation of the motor. The water is admitted to the pump through a trashrack and the pump discharges through an underground pipe into the laterals. As this unit supplies water to two laterals, a gate valve is installed in each discharge pipe so that each lateral may be supplied separately or so as to adjust the flow when both laterals are being supplied simultaneously.

Typical of small drainage pumping plants are the Tule Lake pumping plants of the Klamath project of which plant No. 5 is representative. This plant contains 3 pumping units and consists of a wood structure mounted on timber piling located along the side of the drainage canal. The pumping units are of the low-head, vertical-shaft, propeller type, each having a capacity of 25 second-feet when operating at an average head of 10 feet. The units are direct-connected to vertical, squirrel-cage, induction motors. The pump inlets are protected against weeds and debris by trashracks and the pumps discharge through steel pipe lines into a higher level drainage canal which flows into the lake. Flap valves are provided at the outlet end of each discharge pipe in order to prevent back flow of water from the discharge drainage canal.

The pumping plants described are representative of various plants now constructed and in operation by the Bureau of Reclamation. In the design of each plant, consideration is given to the selection of the most adaptable type of pumping unit for efficient operation under the specified pumping conditions, selection of the proper number of units to give flexibility of operation under the varying seasonal demand, type of structure best suited to the location, most economical arrangement of plant and equipment layout, and extent of auxiliary plant equipment necessary for good operation and maintenance of the pumping units.

Left: Cross section, Tule Lake Pumping Plant No. 5, Klamath project, Oregon-California
Right: Cross section, Glendive pumping plant, Buffalo Rapids project, Montana





Auxiliary

First Crossing, Sacramento River, Central Valley project, California

Boulder City, Boulder Canyon project, Nevada

Bridge building for railroad relocation, Central Valley project

WHEN projects of the Bureau of Reclamation are mentioned the discussion ordinarily centers around the problems of the storage, distribution, and drainage of water and the production of power and its transmission, and scant attention is given to the various incidental problems. These may require construction of new and relocation of existing railroads and highways, construction of bridges, tunnels, and towns; protection of migratory fish; removal of excessive silt from the water to prevent filling the canals; temporary diversion of the stream to permit construction of a dam; and innumerable other auxiliary features. These auxiliary features may assume major importance on some projects, even to the extent of determining the practicability of the project.

The construction of Shasta Dam, Central Valley project, with its attendant reservoir necessitated the relocation of a portion of the main line of the Southern Pacific Railroad and of United States Highway No. 99, both of which, in search of "water grade," had followed the Sacramento River Canyon through the reservoir area. Construction of approximately 30 miles of railroad with 6 passing tracks each a little over 1 mile long; adequate station and operational facilities including buildings, water tanks, water supply, and sewage disposal systems; suitable signal systems and the relocation of telegraph, telephone and power lines; and the construction of about 12½ miles of new highway were included in the program of reservoir clearing. There were 12 tunnels, totaling about 19,000 feet in length, built, and 8 principal bridges 308 to 4,346 feet long, totaling about 12,300 feet. Of special interest is the Pit River bridge, a great double-decked structure now being built to carry both the highway and railroad across an arm of the reservoir. The highway on the upper deck will be about 500 feet above the stream bed. There is about 65 feet between decks. Similar railroad and highway relocations were made at Grand Coulee Dam, Columbia Basin project, of a portion of the Great Northern Railroad requiring about 28 miles of railroad construction and 3½ miles of highway construction, including several bridges and some railroad terminal facilities; and many of smaller scale have been required elsewhere.

A little more unusual is the problem of preserving the migratory fish industry on the streams being utilized for reclamation purposes. Salmon and steelhead trout spawned in fresh water migrate to the sea and return to their native streams at maturity in their turn to spawn. A high dam will block the run of these fish, attempting to reach their spawning grounds beyond, and they will not naturally seek other areas accessible to them,

Works

but rather will die trying to jump the dam. In order to avoid the loss of blocked runs, some means must be provided to allow the fish unrestricted passage over, through, or around any dam built on streams subject to these migrations, or, if that is impossible, as at Grand Coulee Dam, the runs must be salvaged through transplanting. Small dams are provided with fish ladders, and larger dams have found elevators more satisfactory. In such mammoth structures as Grand Coulee Dam no satisfactory means could be found to get the fish over, which, it was discovered, would have been useless anyway since the fingerlings would be killed by the sudden changes of water pressures in their migration downstream over the dam. The alternative was to establish the fish runs in the tributaries which enter the Columbia River below the dam.

Removal of Silt From River Necessary

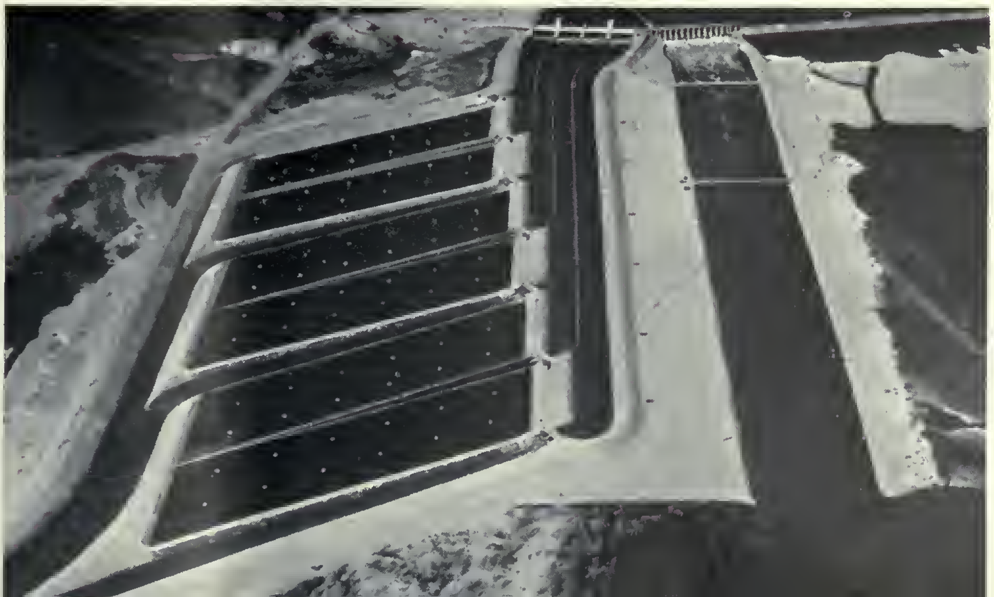
In building the Imperial Dam across the silt-laden Colorado River to divert water for the All-American and Gila Canals, it was necessary to make provision for the removal of the silt to avoid excessive canal maintenance costs. The All-American Canal is designed for an ultimate capacity of 15,155 second-feet, but will be operated for the present at a capacity of 12,000 second-feet. The estimated silt load at 12,000 second-feet is 60,000 tons dry weight per day with a maximum of 90,000 tons per day. The desilting equipment is designed to remove about 80 percent of the silt, allowing the remaining 20 percent to pass through into the canals. This residual silt will be mostly finer than 0.05 millimeter and will probably be carried through the system. The desilting works for the All-American Canal consist of a series of 6 settling basins arranged in pairs, each basin 269 feet wide and 769 feet long with an average depth of 12.5 feet through which the water passes at a velocity of 0.22 feet per second resulting in a detention period of about 21 minutes. Each basin is equipped with 12 rotary type scrapers 125 feet in diameter arranged to move the deposited silt into collecting trenches, from which it is finally sluiced into the river below the dam.

These illustrations are among the major works of incidental occurrence, but by no means all. Every project is different and presents entirely new problems or old problems in new ways. The construction of Boulder City, made necessary by the fact that around the site of Boulder Dam at the outset of construction there were no habitations, might be given as another example of this group of auxiliary works, and many others exist.

Four bridges span the All-American Canal at this point

Migratory fish being loaded on fish truck, Columbia Basin project, Washington

Desilting works, All-American Canal



The Results

FEDERAL Reclamation, since its adoption in 1902, has effected the development or the improvement of water supply for some 3,000,000 acres. These works represent an investment of some $380,000,000, practically all of which is returnable to the United States under existing repayment contracts with the water users. Private initiative and pioneer perseverance in developing irrigation account for another 17,000,000 acres, with a value of more than a billion dollars in works.

These 20,000,000 acres under irrigation lie in the 17 States west of or bisected by the 100th meridian. For the most part land west of the 100th meridian is arid or semiarid, and these classifications make up more than one-third of the area of continental United States. Without irrigation, little of this land can be productive of crops. About 3 percent of it now is irrigated, an amount insufficient to supply all the needs of the population of the region. Agricultural products and processed foods are imported from other areas even into districts actually irrigated. The Federal projects alone provide midwestern, southern, and eastern manufacturers and distributors with an annual market worth more than $200,000,000. Important imports are corn, hog and pork products, cotton, cottonseed and textiles, tobacco and tobacco products, flour and processed cereals, and automobiles and motor supplies. Hardly less in volume of business are clothing and farm implements required in this large area.

The Western States are known for their citrus fruits, their winter and off-season vegetables, their special fruits and potatoes, their cattle and sheep, and their hay and forage production. Under the more stable farming of the irrigated areas where town and city population depend on local crops, the average acreages are about as follows:

	Percent
Alfalfa hay	29
Pasture and forage	13
Cereals	23
Vegetables and truck	11
Cotton and cottonseed	8
Sugar beets	6
Fruits and nuts	4
Seeds	2
Miscellaneous	4
	100

The data are taken from the Federal Reclamation project returns. Crop values for 1939 on the Federal Reclamation projects averaged $37 per acre.

Private initiative had developed about 9,000,000 acres under irrigation by 1902 when the Reclamation Act was adopted and the reclamation fund was created. Private initiative has since doubled its original area, and during the past 38 years the Federal Government has constructed works for a water supply for 3,000,000 acres, about two-thirds of which was rehabilitation of early irrigated areas.

Civic Development

Federal Reclamation farm and community population exceeds 900,000, with about 225,000 persons living on some 50,000 irrigated farms. Approximately 700,000 persons live in 258 cities and towns located on the projects or in the immediate vicinity and largely dependent on the irrigated areas for their livelihood. Reclamation communities are in themselves healthy and thriving communities.

Power production is of considerable value on 13 of the projects. More than 2,000,000,000 kilowatt-hours of electrical energy were produced in 1939; enough to supply a year's power needs to a city of 2,000,000 people. This power is provided for home and farm power use in many varied ways and is often a major factor in project financing.

The care and operation of 16 completed projects or divisions of projects have remained under the direct supervision of the Bureau with annual charges fixed by public notices issued by the Secretary. The water users are required to advance sufficient funds to cover annual cost of operation and maintenance with no water delivered until the charges have been paid. There are 25 projects or divisions of projects where canal systems have been completed and turned over to organized water users for operation and maintenance under contracts. With few exceptions the care and operation of storage dams and reservoirs have been retained by the Bureau.

Works now under construction or about to begin will add some 2,000,000 acres to the Federal Reclamation total within the next decade. The Columbia Basin project will in the following decade make available for settlement another million acres. About half of this total will be lands available for settlement and half lands already settled which will be supplied with adequate water.

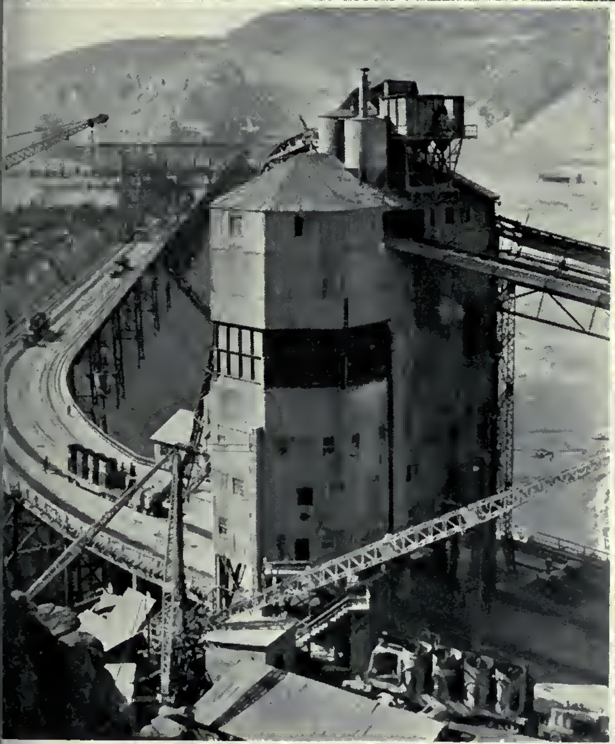
Operating projects have repaid more than $60,000,000 on the construction costs, and collections are generally satisfactory.

List of Projects, Divided as to Purposes, Now Under Construction

Project and State	*Acres*	
Supplemental water of vital necessity for present irrigated areas with flood control and/or power contributing to the relief needed:		
Central Valley, California	2, 000, 000	
All-American Canal, California	674, 500	
Colorado-Big Thompson, Colorado	615, 000	
		3, 289, 500
Supplemental water for early irrigated areas with extension of the areas to meet settlement demands and distribute charges:		
Vale, Oregon	30, 000	
Owyhee, Oregon-Idaho	115, 400	
Pine River, Colorado	69, 000	
Rapid Valley, South Dakota	12, 000	
		226, 400
Extensions of successful projects to meet settlement demands:		
Boise-Payette (power), Idaho	48, 000	
Sun River-Sun River Slope, Montana	17, 000	
Klamath-Tule Lake, Oregon-California	11, 500	
Yakima-Roza (power), Washington	72, 000	
Riverton, Wyoming	68, 000	
Shoshone, Wyoming	41, 000	
		257, 500

Project and State	*Acres*	
Stabilization of settlement and agriculture through irrigation:		
Bismarck, North Dakota	4, 900	
Buffalo Rapids No. 1, Montana	12, 000	
Buford-Trenton, North Dakota	13, 400	
Mirage Flats, Nebraska	12, 000	
Buffalo Rapids No. 2, Montana	11, 600	
Altus, Oklahoma	70, 000	
Tucumcari, New Mexico	45, 000	
		168, 90
New development for early settlement requirements:		
Deschutes, Oregon	50, 000	
Kendrick (power), Wyoming	35, 000	
Gila, Arizona	150, 000	
		235, 00
New development for future growth and settlement demands:		
Columbia Basin (power), Washington	1, 200, 000	
		1, 200, 00
Total		5, 377, 30

A list of projects and their operating officials appears on the inside of the back cover page.



NOTES FOR CONTRACTORS

Specification No.	Project	Bids opened	Work or material	Low bidder		Bid	Terms	Contract awarded
				Name	Address			
906	Parker Dam Power, Calif.-Ariz.	April 29	Power transformers for Phoenix terminal substation and Parker power plant.	Allis-Chalmers Manufacturing Co.	Milwaukee, Wis	[1] $426,800.00	F. o. b. Phoenix, Ariz	May 29
				Moloney Electric Co	St. Louis, Mo	[2] 218,000.00	F. o. b. Earn, Calif	Do.
1327-D	Rio Grande, N. Mex.-Tex.	May 8	Furnishing and erecting chain-link fences along the Franklin Canal.	Pittsburgh Steel Co	Pittsburgh, Pa	36,454.44	F. o. b. Alton, Ill., St. Louis, Mo., and Monessen, Pa.	May 27
1356-D	Boulder Canyon, Ariz.-Nev.	May 14	Carbon-dioxide fire-extinguishing equipment for Boulder power plant.	C-O-Two Fire Equipment Co.	Newark, N. J	[3] 3,748.10	F. o. b. Boulder City, Nev.	May 31
						[4] 1,905.02	do	Do.
1360-D	Central Valley, Calif	May 16	Structural-steel frames and accessory metalwork pipe handrails, and accessory metal work, 6 screen frames, 6 aprons, and miscellaneous trashrack metalwork.	Paxton and Vierling Iron Works.	Omaha, Nebr	[3] 2,600.00	F. o. b. Knightsen, Calif.; discount ½ percent.	May 29
				Western Pipe & Steel Co	San Francisco, Calif.	[4] 533.00	F. o. b. South San Francisco.	Do.
				do	do	[5] 600.00	do	Do.
				California Steel Products Co.	do	[6] 546.00	F. o. b. San Francisco; discount 2 percent.	Do.
				Milwaukee Bridge Co	Milwaukee, Wis	[7] 1,394.00	F. o. b. Milwaukee; discount ½ percent.	Do.
B-22, 332-A	Kendrick, Wyo	May 6	Electrical conductor and accessories.	Aluminum Co. of America	Washington, D. C	[8] 85,473.02	F. o. b. Massena, N. Y	May 27
1363-D	Provo River, Utah	May 17	Two 72-inch diameter welded plate-steel pipes with 57-inch diameter branches.	Western Pipe & Steel Co. of California.	Los Angeles, Calif	47,875.00	F. o. b. Los Angeles	June 6
1351-D	Columbia Basin, Wash	April 22	Bulkhead-gate tracks for 10 pairs of bulkhead-gate units for upstream face of Grand Coulee Dam.	Koppers Co. (Bartlett-Hayward Division).	Baltimore, Md	52,000.00	F. o. b. Baltimore	June 10
1357-D	do	May 15	Twelve 500-kilovolt-ampere, 6,900- to 230/460-volt; six 100-kilovolt-ampere, 6,900- to 115/230-volt; and six 50-kilovolt-ampere, 6,900- to 115/230-volt, 60-cycle, outdoor-type transformers.	American Transformer Co	Newark, N. J	34,542.00	F. o. b. Odair	June 8
1365-D	do	May 17	Rails and accessory metalwork for gantry-crane tracks at Grand Coulee Dam.	Carnegie-Illinois Steel Corporation.	Denver, Colo	[3] 15,434.00	F. o. b. Lorain, Ohio	June 7
				Bethlehem Steel Co	Chicago, Ill	[4] 5,250.00	F. o. b. Chicago, Ill	
				Carnegie-Illinois Steel Corporation.	Denver, Colo	[5] 11,411.00	F. o. b. Johnstown, Pa	Do
1358-D	Central Valley, Calif	May 16	Embedded metalwork for anchorages for drum gates at Friant Dam.	Philips & Davies Inc	Kenton, Ohio	[3] 5,000.00	F. o. b. Kenton	Do.
				American Bridge Co	Denver, Colo	[4] 7,037.00	F. o. b. Gary, Ind	June 5
				California Steel Products Co.	San Francisco, Calif	[5] 6,919.00	F. o. b. San Francisco	June 1
1359-D	Rio Grande, N. Mex.-Tex.	May 14	Disconnecting switch, transformers, and meter panel for Las Cruces substation	Royal Electric Manufacturing Co.	Chicago, Ill	[3] 2,342.00	F. o. b. Las Cruces	June 3
				General Electric Co	Schenectady, N. Y	[4] 8,386.52	do	June 4
				Westinghouse Electric & Manufacturing Co.	Denver, Colo	[5] 217.00	do	Do.
1364-D	Altus, Okla	May 20	Structural steel, metal siding and roofing, doors and other materials for warehouses.	Des Moines Steel Co	Des Moines, Iowa	4,076.00	F. o. b. Des Moines; discount ½ percent.	June 6
899	Kendrick, Wyo	April 4	Construction of 7,500-kilovolt-ampere substation at Laramie, Wyo.	Collier Electric & Radio Co.	Denver, Colo	64,275.00	Westinghouse equipment	June 10
1361-D	Yakima-Roza, Wash	May 13	13,000 barrels of modified portland cement in cloth sacks.	Superior Portland Cement Co.	Seattle, Wash	26,000.00	Discount and sack allowance $0.50 per barrel.	June 15
1366-D	Pine River, Colo	May 17	10,000 barrels of modified portland cement in cloth sacks.	Colorado Portland Cement Co.	Denver, Colo	25,000.00	do	Do.
1367-D	Rio Grande, N. Mex.-Tex.	May 29	Construction of 115-kilovolt transmission line, Elephant Butte to Las Cruces.	Vancott Co	Los Angeles, Calif	31,318.25		June 13
1368-D	Columbia Basin, Wash	June 5	Structural-steel work, floor plates and gratings for gate hoist structure at Grand Coulee Dam.	Valley Iron Works	Yakima, Wash	6,480.00	Discount 5 percent	Do.

[1] Schedule 1. [2] Schedule 2. [3] Item 1. [4] Item 2. [5] Item 3. [6] Item 4. [7] Item 5. [8] Schedule 3.

HARRY CADEN RETIRES

HARRY CADEN, senior clerk in the Denver office, who is to retire from active service with the Government in August, was tendered a farewell banquet at the Shirley-Savoy Hotel on May 27.

Mr. Caden was born in Cincinnati, Ohio, August 14, 1870. After completing school he engaged in mercantile pursuits for about 5 years in that city. In 1895 he moved to Los Angeles, Calif., and entered the Government service in September 1901, in the construction department of the United States Navy at San Francisco, where was built every type of vessel used in the Navy at that time, among them being the first submarines and the last of the Monitor type of gunboat. His duties were in connection with the keeping of the construction accounts.

On March 21, 1906, Mr. Caden received an appointment in the Reclamation Service as bookkeeper on the Klamath project with headquarters at Klamath Falls, Oreg. His service with the Bureau has been continuous since that date, and he has had numerous progressively more important assignments in several offices of the Bureau, including the Supervising Engineer's office, Portland, Oreg.; the Flathead project office, St. Ignatius, Mont.; and the Washington and Denver offices. He was transferred from Washington to Denver April 1, 1920, for assignment as special fiscal agent, at which time practically all disbursements for the various projects of the Bureau were made by the Denver office fiscal agent. He continued in that position until the fall of 1935, when the disbursing of public funds was transferred from the Bureau's special fiscal agents to regional disbursing officers, directly under the Treasury Department. During his period of service as fiscal agent, Mr. Caden handled well over 100 million dollars for the Bureau of Reclamation. Since the fall of 1935, he has been assigned to the auditing of all vouchers in the Denver office prior to their formal approval and submission to the disbursing officers for payment.

Reaching the statutory age for retirement, Mr. Caden will be dropped from the active rolls of the Bureau at the close of August 31, 1940, and placed on the retired list after having rendered nearly 39 years of continuous service to the Federal Government. His actual service in the Denver office ended May 31, after which he was granted annual leave until the date of actual separation.

Mr. Caden carries with him the very best wishes from his host of friends in the Denver and other offices of the Bureau of Reclamation.

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CUT ALONG THIS LINE

(Date)..................................

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Bureau of Reclamation,
Washington, D. C.

SIR: I am enclosing my check [1] (or money order) for $1.00 to pay for a year's subscription to THE RECLAMATION ERA.

Very truly yours,

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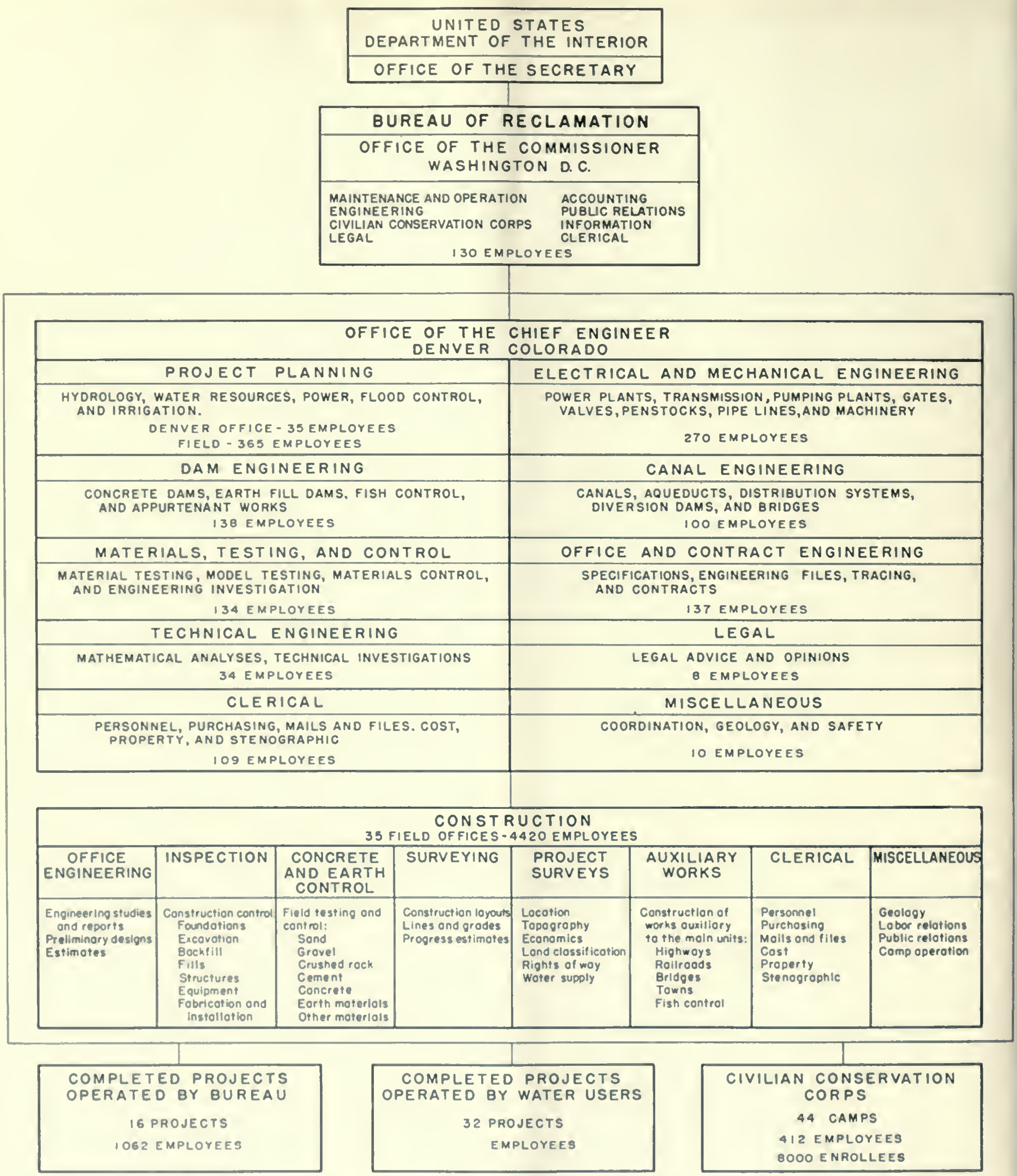

UNITED STATES
DEPARTMENT OF THE INTERIOR
OFFICE OF THE SECRETARY

BUREAU OF RECLAMATION
OFFICE OF THE COMMISSIONER
WASHINGTON D. C.

MAINTENANCE AND OPERATION
ENGINEERING
CIVILIAN CONSERVATION CORPS
LEGAL
ACCOUNTING
PUBLIC RELATIONS
INFORMATION
CLERICAL

130 EMPLOYEES

OFFICE OF THE CHIEF ENGINEER
DENVER COLORADO

PROJECT PLANNING	ELECTRICAL AND MECHANICAL ENGINEERING
HYDROLOGY, WATER RESOURCES, POWER, FLOOD CONTROL, AND IRRIGATION. DENVER OFFICE - 35 EMPLOYEES FIELD - 365 EMPLOYEES	POWER PLANTS, TRANSMISSION, PUMPING PLANTS, GATES, VALVES, PENSTOCKS, PIPE LINES, AND MACHINERY 270 EMPLOYEES
DAM ENGINEERING	**CANAL ENGINEERING**
CONCRETE DAMS, EARTH FILL DAMS, FISH CONTROL, AND APPURTENANT WORKS 138 EMPLOYEES	CANALS, AQUEDUCTS, DISTRIBUTION SYSTEMS, DIVERSION DAMS, AND BRIDGES 100 EMPLOYEES
MATERIALS, TESTING, AND CONTROL	**OFFICE AND CONTRACT ENGINEERING**
MATERIAL TESTING, MODEL TESTING, MATERIALS CONTROL, AND ENGINEERING INVESTIGATION 134 EMPLOYEES	SPECIFICATIONS, ENGINEERING FILES, TRACING, AND CONTRACTS 137 EMPLOYEES
TECHNICAL ENGINEERING	**LEGAL**
MATHEMATICAL ANALYSES, TECHNICAL INVESTIGATIONS 34 EMPLOYEES	LEGAL ADVICE AND OPINIONS 8 EMPLOYEES
CLERICAL	**MISCELLANEOUS**
PERSONNEL, PURCHASING, MAILS AND FILES. COST, PROPERTY, AND STENOGRAPHIC 109 EMPLOYEES	COORDINATION, GEOLOGY, AND SAFETY 10 EMPLOYEES

CONSTRUCTION
35 FIELD OFFICES - 4420 EMPLOYEES

OFFICE ENGINEERING	INSPECTION	CONCRETE AND EARTH CONTROL	SURVEYING	PROJECT SURVEYS	AUXILIARY WORKS	CLERICAL	MISCELLANEOUS
Engineering studies and reports Preliminary designs Estimates	Construction control: Foundations Excavation Backfill Fills Structures Equipment Fabrication and installation	Field testing and control: Sand Gravel Crushed rock Cement Concrete Earth materials Other materials	Construction layouts Lines and grades Progress estimates	Location Topography Economics Land classification Rights of way Water supply	Construction of works auxiliary to the main units: Highways Railroads Bridges Towns Fish control	Personnel Purchasing Mails and files Cost Property Stenographic	Geology Labor relations Public relations Camp operation

COMPLETED PROJECTS
OPERATED BY BUREAU
16 PROJECTS
1062 EMPLOYEES

COMPLETED PROJECTS
OPERATED BY WATER USERS
32 PROJECTS
EMPLOYEES

CIVILIAN CONSERVATION
CORPS
44 CAMPS
412 EMPLOYEES
8000 ENROLLEES

FUNCTIONAL ORGANIZATION OF THE BUREAU OF RECLAMATION

238721 U. S. GOVERNMENT PRINTING OFFICE: 1940

ADMINISTRATIVE ORGANIZATION OF THE BUREAU OF RECLAMATION

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Projects under construction or operated in whole or in part by the Bureau of Reclamation

Project	Office	Official in charge		Chief clerk	District counsel	
		Name	Title		Name	Address
All-American Canal	Yuma, Ariz	Leo J. Foster	Construction engineer	J. C. Thrailkill	R. J. Coffey	Los Angeles, Calif.
Altus	Altus, Okla	Russell S. Lieurance	Construction engineer	Edgar A. Peek	H. J. S. Devries	El Paso, Tex.
Belle Fourche	Newell, S. Dak	F. C. Youngblutt	Superintendent		W. J. Burke	Billings, Mont.
Boise	Boise, Idaho	R. J. Newell	Construction engineer	Robert B. Smith	B. E. Stoutemyer	Portland, Oreg.
Boulder Canyon [1]	Boulder City, Nev	Irving C. Harris	Director of power	Gail H. Baird	R. J. Coffey	Los Angeles, Calif.
Buffalo Rapids	Glendive, Mont	Paul A. Jones	Construction engineer	Edwin M. Bean	W. J. Burke	Billings, Mont.
Buford-Trenton	Williston, N. Dak	Parley R. Neeley	Resident engineer	Robert L. Newman	W. J. Burke	Billings, Mont.
Carlsbad	Carlsbad, N. Mex	L. E. Foster	Superintendent	E. W. Shepard	H. J. S. Devries	El Paso, Tex.
Central Valley	Sacramento, Calif	W. R. Young	Supervising engineer	E. R. Mills	R. J. Coffey	Los Angeles, Calif.
Shasta Dam	Redding, Calif	Ralph Lowry	Construction engineer		R. J. Coffey	Los Angeles, Calif.
Friant division	Friant, Calif	R. B. Williams	Construction engineer		R. J. Coffey	Los Angeles, Calif.
Delta division	Antioch, Calif	Oscar C. Boden	Construction engineer		R. J. Coffey	Los Angeles, Calif.
Colorado-Big Thompson	Estes Park, Colo	Porter J. Preston	Supervising engineer	C. M. Voyen	J. R. Alexander	Salt Lake City, Utah.
Colorado River	Austin Tex	Ernest A. Moritz	Construction engineer	William F. Sha	H. J. S. Devries	El Paso, Tex.
Columbia Basin	Coulee Dam, Wash	F. A. Banks	Supervising engineer	C. B. Funk	B. E. Stoutemyer	Portland, Oreg.
Deschutes	Bend, Oreg	D. S. Stuver	Construction engineer	Noble O. Anderson	B. E. Stoutemyer	Portland, Oreg.
Gila	Yuma, Ariz	Leo J. Foster	Construction engineer	J. C. Thrailkill	R. J. Coffey	Los Angeles, Calif.
Grand Valley	Grand Junction, Colo	W. J. Chiesman	Superintendent	Emil T. Ficenec	J. R. Alexander	Salt Lake City, Utah.
Humboldt	Reno, Nev	Floyd M. Spencer	Construction engineer [2]		J. R. Alexander	Salt Lake City, Utah.
Kendrick	Casper, Wyo	Irvin J. Matthews	Construction engineer [2]	George W. Lyle	W. J. Burke	Billings, Mont.
Klamath	Klamath Falls, Oreg	B. E. Hayden	Superintendent	W. I. Tingley	B. E. Stoutemyer	Portland, Oreg.
Milk River	Malta, Mont	H. H. Johnson	Superintendent	E. E. Chabot	W. J. Burke	Billings, Mont.
Minidoka	Burley, Idaho	Stanley R. Marean	Superintendent	G. C. Patterson	B. E. Stoutemyer	Portland, Oreg.
Minidoka Power Plant	Rupert, Idaho	S. A. McWilliams	Resident engineer		B. E. Stoutemyer	Portland, Oreg.
Mirage Flats	Hemingford, Nebr	Denton J. Paul	Construction engineer		W. J. Burke	Billings, Mont.
Moon Lake	Provo, Utah	E. O. Larson	Construction engineer	Francis J. Farrell	J. R. Alexander	Salt Lake City, Utah.
North Platte	Guernsey, Wyo	C. F. Gleason	Superintendent of power	A. T. Stimpfig	W. J. Burke	Billings, Mont.
Ogden River	Provo, Utah	E. O. Larsen	Construction engineer	Francis J. Farrell	J. R. Alexander	Salt Lake City, Utah.
Orland	Orland, Calif	D. L. Carmody	Superintendent	W. D. Funk	R. J. Coffey	Los Angeles, Calif.
Owyhee	Boise, Idaho	R. J. Newell	Construction engineer	Robert B. Smith	B. E. Stoutemyer	Portland, Oreg.
Parker Dam Power	Parker Dam, Calif	E. C. Koppen	Construction engineer	George B. Snow	R. J. Coffey	Los Angeles, Calif.
Pine River	Vallecito, Colo	Charles A. Burns	Construction engineer	Frank E. Cawn	J. R. Alexander	Salt Lake City, Utah.
Rapid Valley	Rapid City, S. D	Horace V. Hubbell	Construction engineer	Jos. P. Siebeneicher	W. J. Burke	Billings, Mont.
Provo River	Provo, Utah	E. O. Larson	Construction engineer	Francis J. Farrell	J. R. Alexander	Salt Lake City, Utah.
Rio Grande	El Paso, Tex	L. R. Fiock	Superintendent	H. H. Berryhill	H. J. S. Devries	El Paso, Tex.
Elephant Butte Power Plant	Elephant Butte, N. Mex	C. O. Dale	Acting resident engineer	H. H. Berryhill	H. J. S. Devries	El Paso, Tex.
Riverton	Riverton, Wyo	H. D. Comstock	Superintendent	C. B. Wentzel	W. J. Burke	Billings, Mont.
Shoshone	Powell, Wyo	L. J. Windle	Superintendent [2]	L. J. Windle [2]	W. J. Burke	Billings, Mont.
Heart Mountain division	Cody, Wyo	Walter F. Kemp	Construction engineer	L. J. Windle [2]	W. J. Burke	Billings, Mont.
Sun River	Fairfield, Mont	A. W. Walker	Superintendent		W. J. Burke	Billings, Mont.
Truckee River Storage	Reno, Nev	Floyd M. Spencer	Construction engineer [2]		J. R. Alexander	Salt Lake City, Utah.
Tucumcari	Tucumcari, N. Mex	Harold W. Mutch	Engineer	Charles L. Harris	H. J. S. Devries	El Paso, Tex.
Umatilla (McKay Dam)	Pendleton, Oreg	C. L. Tice	Reservoir superintendent		B. E. Stoutemyer	Portland, Oreg.
Uncompahgre: Repairs to canals	Montrose, Colo	Herman R. Elliott	Construction engineer [2]	Ewalt P. Anderson	J. R. Alexander	Salt Lake City, Utah.
Upper Snake River Storage [3]	Ashton, Idaho	I. Donald Jerman	Construction engineer [2]	Emmanuel V. Hillius	B. E. Stoutemyer	Portland, Oreg.
Vale	Vale, Oreg	C. C. Ketchum	Superintendent		B. E. Stoutemyer	Portland, Oreg.
Yakima	Yakima, Wash	J. S. Moore	Superintendent	Conrad J. Ralston	B. E. Stoutemyer	Portland, Oreg.
Roza division	Yakima, Wash	Charles E. Crownover	Construction engineer	Alex S. Harker	B. E. Stoutemyer	Portland, Oreg.
Yuma	Yuma, Ariz	C. B. Elliott	Superintendent	Jacob T. Davenport	R. J. Coffey	Los Angeles, Calif.

[1] Boulder Dam and Power Plant.

[2] Acting.

[3] Island Park and Grassy Lake Dams.

Projects or divisions of projects of Bureau of Reclamation operated by water users

Project	Organization	Office	Operating official		Secretary	
			Name	Title	Name	Address
Baker (Thief Valley division) [1]	Lower Powder River irrigation district	Baker, Oreg	A. J. Ritter	President	F. A. Phillips	Keating.
Bitter Root [4]	Bitter Root irrigation district	Hamilton, Mont	G. R. Walsh	Manager	Elsie H. Wagner	Hamilton.
Boise [1]	Board of Control	Boise, Idaho	Wm. H. Tuller	Project manager	L. P. Jensen	Boise.
Boise [1]	Black Canyon irrigation district	Notus, Idaho	W. H. Jordan	Superintendent	L. M. Watson	Caldwell.
Burnt River	Burnt River irrigation district	Huntington, Oreg	Edward Sullivan	President	Harold H. Hursh	Huntington.
Frenchtown	Frenchtown irrigation district	Frenchtown, Mont	Edward Donlan	President	Ralph P. Schaffer	Huson.
Fruitgrowers Dam	Orchard City Irrigation Co	Austin, Colo	S. F. Newman	Superintendent	A. W. Lanning	Austin.
Grand Valley, Orchard Mesa [3]	Orchard Mesa irrigation district	Grand Junction, Colo	C. W. Tharp	Superintendent	C. J. McCormich	Grand Jctn.
Humboldt	Pershing County water conservation district	Lovelock, Nev	Roy F. Meffley	Superintendent	C. H. Jones	Lovelock.
Huntley [4]	Huntley irrigation district	Ballantine, Mont	E. E. Lewis	Manager	H. S. Elliott	Ballantine.
Hyrum [3]	South Cache W. U. A	Wellsville, Utah	B. L. Mendenhall	Superintendent	Harry C. Parker	Logan.
Klamath, Langell Valley [1]	Langell Valley irrigation district	Bonanza, Oreg	Chas. A. Revell	Manager	Chas. A. Revell	Bonanza.
Klamath, Horsefly [1]	Horsefly irrigation district	Bonanza, Oreg	Henry Schmor, Jr	President	Dorothy Eyers	Bonanza.
Lower Yellowstone [4]	Board of Control	Sidney, Mont	Axel Persson	Manager	Axel Persson	Sidney.
Milk River: Chinook division [4]	Alfalfa Valley irrigation district	Chinook, Mont	A. L. Benton	President	R. H. Clarkson	Chinook.
	Fort Belknap irrigation district	Chinook, Mont	H. B. Bonefright	President	L. V. Bogy	Chinook.
	Zurich irrigation district	Harlem, Mont	C. A. Watkins	President	H. M. Montgomery	Chinook.
	Harlem irrigation district	Harlem, Mont	Thos. M. Everett	President	Geo. H. Tout	Harlem.
	Paradise Valley irrigation district	Zurich, Mont	R. E. Musgrove	President	J. F. Sharples	Zurich.
Minidoka: Gravity [1]	Minidoka irrigation district	Rupert, Idaho	Frank A. Ballard	Manager	O. W. Paul	Rupert.
Pumping	Burley irrigation district	Burley, Idaho	Hugh L. Crawford	Manager	Frank O. Redfield	Burley.
Gooding [1]	Amer. Falls Reserv. Dist. No. 2	Gooding, Idaho	S. T. Baer	Manager	Ida M. Johnson	Gooding.
Newlands [3]	Truckee-Carson irrigation district	Fallon, Nev	W. H. Wallace	Manager	H. W. Emery	Fallon.
North Platte: Interstate division [4]	Pathfinder irrigation district	Mitchell, Nebr	T. W. Parry	Manager	Flora K. Schroeder	Mitchell.
Fort Laramie division [4]	Gering-Fort Laramie irrigation district	Gering, Nebr	W. O. Fleenor	Superintendent	C. G. Klingman	Gering.
Fort Laramie division [4]	Goshen irrigation district	Torrington, Wyo	Floyd M. Roush	Superintendent	Mary E. Harrach	Torrington.
Northport division [4]	Northport irrigation district	Northport, Nebr	Mark Iddings	Manager	Mabel J. Thompson	Bridgeport.
Ogden River	Ogden River W. U. A	Ogden, Utah	David A. Scott	Superintendent	Wm. P. Stephens	Ogden.
Okanogan [1]	Okanogan irrigation district	Okanogan, Wash	Nelson D. Thorp	Manager	Nelson D. Thorp	Okanogan.
Salt Lake Basin (Echo Res.) [3]	Weber River Water Users' Assn	Ogden, Utah	D. D. Harris	Manager	D. D. Harris	Layton.
Salt River [2]	Salt River Valley W. U. A	Phoenix, Ariz	H. J. Lawson	Superintendent	F. C. Henshaw	Phoenix.
Sanpete:						
Ephraim division	Ephraim Irrigation Co	Ephraim, Utah	Jos. H. Thomson	President	John K. Olsen	Ephraim.
Spring City division	Horseshoe Irrigation Co	Spring City, Utah	Vivian Larson	President	James W. Blain	Spring City.
Shoshone: Garland division [4]	Shoshone irrigation district	Powell, Wyo	Paul Nelson	Acting irri. supt	Harry Barrows	Powell.
Frannie division [4]	Deaver irrigation district	Deaver, Wyo	Floyd Lucas	Manager	R. J. Schwendiman	Deaver.
Stanfield	Stanfield irrigation district	Stanfield, Oreg	Leo F. Clark	Superintendent	F. A. Baker	Stanfield.
Strawberry Valley	Strawberry Water Users' Assn	Payson, Utah	S. W. Grotegut	President	E. C. Breeze	Payson.
Sun River: Fort Shaw division [4]	Fort Shaw irrigation district	Fort Shaw, Mont.	C. L. Bailey	Manager	C. L. Bailey	Fort Shaw.
Greenfields division [4]	Greenfields irrigation district	Fairfield, Mont	A. W. Walker	Manager	H. P. Wangen	Fairfield.
Umatilla, East division [1]	Hermiston irrigation district	Hermiston, Oreg	E. D. Martin	Manager	Enos D. Martin	Hermiston.
West division [1]	West Extension irrigation district.	Irrigon, Oreg	A. C. Houghton	Manager	A. C. Houghton	Irrigon.
Uncompahgre [3]	Uncompahgre Valley W. U. A	Montrose, Colo	Jesse R. Thompson	Manager	H. D. Calloway	Montrose.
Upper Snake River Storage	Fremont-Madison irrigation district	Ashton, Idaho	H. G. Fuller	President	John T. White	St. Anthony.
Weber River	Weber River W. U. A	Ogden, Utah	D. D. Harris	Manager	D. D. Harris	Ogden.
Yakima, Kittitas division [1]	Kittitas reclamation district	Ellensburg, Wash	G. G. Hughes	Acting manager	G. L. Sterling	Ellensburg.

[1] B. E. Stoutemyer, district counsel, Portland, Oreg.

[2] R. J. Coffey, district counsel, Los Angeles, Calif.

[3] J. R. Alexander, district counsel, Salt Lake City, Utah.

[4] W. J. Burke, district counsel, Billings, Mont.

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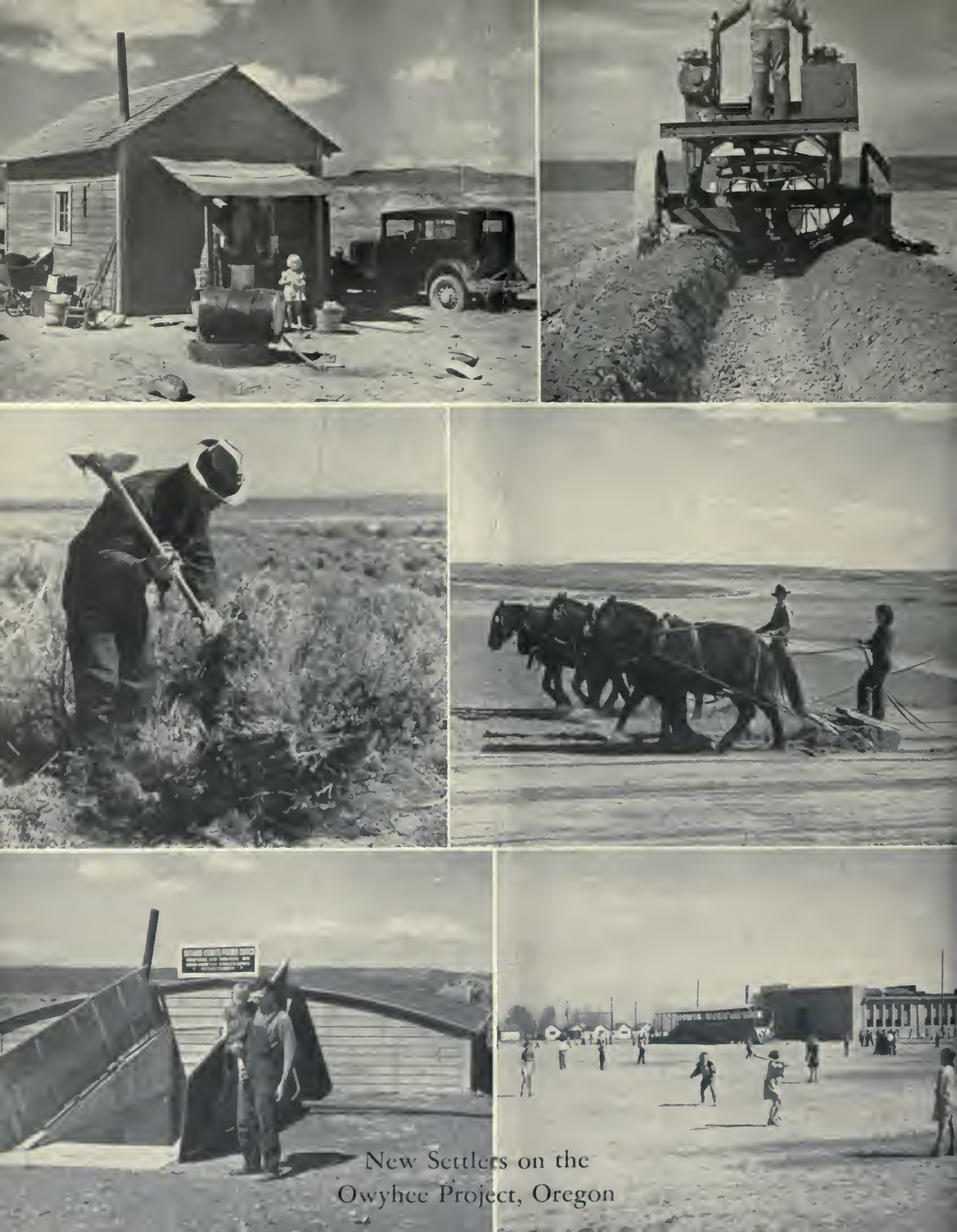
SALLIE A. B. COE, *Editor.*



New Settlers on the Owyhee Project, Oregon

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THE RECLAMATION ERA

AUGUST 1940

THE INLAY TO BE PLACED IN THIS GREAT CAVITY WILL BE SHASTA DAM, CENTRAL VALLEY PROJECT, CALIFORNIA

Appropriations for Construction

FISCAL YEAR 1941

THE Interior Department Appropriation Act, 1941, was approved by the President on June 18, 1940 (Public, 640, 76th Cong., 3d sess.). Appropriations for construction by the Bureau of Reclamation for the fiscal year commencing July 1, 1940, total $60,822,000, an amount to continue a program of construction commensurate with those of recent years when regular appropriations were supplemented with emergency fund allocations. The regular appropriation act and the First Deficiency Act approved in April 1940 contain the following items:

Arizona-California:	
Parker Dam power project	$3,500,000
California:	
All-American Canal project	1,500,000
Central Valley project	28,600,000
Colorado:	
Colorado-Big Thompson project	2,850,000
Pine River project	400,000
San Luis Valley project	150,000
Uncompahgre project	100,000
Idaho:	
Boise-Payette project	900,000
Montana:	
Sun River project	50,000
Nevada:	
Humboldt project	100,000
New Mexico:	
Carlsbad project	100,000
New Mexico-Texas:	
Rio Grande project:	
Elephant Butte power	1,089,000
Oregon:	
Deschutes project	400,000
Oregon-California:	
Klamath project:	
Modoc division	200,000
Texas:	
Colorado River project:	
Marshall Ford Dam	3,000,000
Utah:	
Provo River project	1,250,000
Washington:	
Grand Coulee Dam project	19,000,000
Yakima-Roza project	500,000
Wyoming:	
Kendrick project	900,000
Riverton project	200,000
Shoshone-Heart Mountain project	350,000
General investigations	600,000
Boulder Canyon project	5,000,000
Water Conservation and Utility projects	3,500,000

One new project is provided for, i. e., the San Luis Valley project in Colorado. An appropriation of $150,000 is now available for further investigations, exploratory and preparatory work, and commencement of construction in accordance with House Document numbered 693, Seventh-sixth Congress, third session. The project contemplates the construction of multiple-purpose reservoirs on the Rio Grande and Conejos Rivers in the San Luis Valley of southern Colorado to furnish a supplemental water supply to 400,000 acres of irrigated land and to alleviate flood damage along these streams in Colorado and New Mexico, and the construction of a sump drain to augment the flow of the Rio Grande by means of drainage return from the Closed Basin and permit an equal amount of Rio Grande water to be used in the basin.

An appropriation of $200,000 is now available to commence construction of a new development on the Klamath project in Oregon-California, generally known as the Modoc unit. This development will be undertaken by the Bureau of Reclamation with the cooperation of the Bureau of Biological Survey. The project involves the construction of a tunnel, pumping plants, drainage system, dikes, canals, and laterals to convey water from the Tule Lake area to Lower Klamath Lake. The water to be conveyed will reduce flood damages in the Tule Lake area, will permit a greater income to the United States from leases in that area, and will eliminate a dust nuisance now prevailing in the Lower Klamath Lake area. The project is considered to be of outstanding importance in the rehabilitation of waterfowl in the Pacific flyway. Lower Klamath Lake formerly was one of the greatest duck havens on the Pacific coast.

Although the 1940 appropriation act contained an appropriation of $5,000,000 for water conservation and utility projects to be constructed in the Great Plains drought area, the 1941 appropriation of $3,500,000 is to be expended for similar projects pursuant to the provisions of the act of August 11, 1939, known as the Wheeler-Case Act. This appropriation is to be allotted by the Secretary of the Interior and is to be supplemented by relief funds and Civilian Conservation Corps enrollees.

The appropriations for the continuation of construction work now under way will provide adequate construction programs.

JOHN C. PAGE,
Commissioner of Reclamation.

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Kansas City, Mo.

PRICE
ONE
DOLLAR
A YEAR

THE RECLAMATION ERA

VOLUME 30 • AUGUST 1940 • NUMBER 8

Engineering Profession Offers Broadened Opportunities

By JOHN C. PAGE, *Commissioner of Reclamation* [1]

I SUSPECT you would like to have me tell you what I believe the opportunities to be in the profession of engineering in which you expect shortly to be engaged. Two years ago, at the annual round-up of the Nebraska Engineering Society at Omaha, I told a group of your elder brothers, professionally speaking, that we have entered a new day which opens many broad opportunities to the engineer, adding, however, that to seize these opportunities he must be an engineer plus.

He must be an engineer as adept as ever with his slide rule, his transit, and his blue prints, but he needs additional qualifications of leadership and broad social knowledge to assume the place which may be his in this new era which emphasizes conservation.

In all the broad new conservation programs, engineers will be needed, for all of these programs call for construction or reconstruction.

I will repeat what I said in Omaha that conservation is not a political issue; it draws its supporters from all parties and from all walks of life. Introduction of a comprehensive conservation program at this time means that we have turned our backs upon the practice of exploiting our natural resources for temporary and immediate gain without regard for the future. It means that we have substituted rather, a policy of husbanding our resources in a manner which will result in their broad and most beneficial use in our generation and yet will preserve their usefulness for future generations.

One of the most difficult problems facing the administrators of these conservation activities is, and has been, to find technically qualified engineers who also have a sympathetic understanding of the purposes of the work.

Leadership is essential to any permanent solution of our conservation problems; leadership which combines sound technical training with the practical view it gives and a broad understanding of the public weal with which to comprehend a bigger pattern than any which can be transposed on drafting paper.

An able, well-rounded engineer once told me that as a young man he worked 5 years on a job without knowing who was to use the data he gathered or for what purpose. His contribution could have been no more under those circumstances than one toward the perfection of engineering designs. On the other hand, many proposals in the name of conservation have been put forward by men with vision, but with utterly no understanding of the technical problems involved. The results are equally bad for conservation progress.

Engineering in Reclamation Field

Let us consider a more specific field. I long since have learned that it is unsafe to assume that any audience is familiar with Federal reclamation, the field in which I have worked virtually all my life since I left here with a brand new sheepskin. This program, one of the oldest in the conservation field, is designed to bring the scant waters of the arid and semiarid West to the arable land, for the conservation and beneficial use of both these fundamental resources. Since 1902 when this work was undertaken, great progress has been made. This progress can best be measured in the number of homes successfuly established, and not in the number and size of the dams built and canals dug. It is more significant that Grand Coulee Dam, for exmaple, will improve the lot of half a million or more American people than that Grand Coulee Dam is to be the largest structure of its kind so far conceived by man. An engineer can be forgiven some pride in a technical job well done, if he remembers that great works are not measured by cubic content. If he forgets that usefulness and service are the objectives, however, his structure might just as well be a useless monument.

The importance of the Federal reclamation program, largely conceived and worked out by engineers, is found in these facts:

It has provided the opportunities which have resulted in establishment of decent homes for nearly 1,000,000 people on more than 52,000 farms and in more than 250 towns and cities situated among these farms. It has reclaimed more than 3,000,000 acres from the desert status and made this great area so productive that on the average it yields crops which are sold for more than $100,000,000 annually. These man-made oases have provided markets for manufactures and the products of American labor more valuable than our markets in most of the foreign lands with which we trade.

In other words, this conservation program has strengthened both the social and economic life of our country through improvements of lasting usefulness. Is not that more important than the fact that to do this, the engineers of the Bureau at five different times in 38 years have had to design and build the highest dam then in existence in the world?

Some students may feel cheated because Boulder and Grand Coulee Dams already have been built. There may never be an occasion or opportunity again to build such structures. Boulder Dam is 725 feet high and has created Lake Mead, the largest artificial reservoir in the world. Grand Coulee Dam will have 11,250,000 cubic yards of concrete within it. Perhaps there will not be another All-American Canal, an irrigation ditch as large as some important rivers. On the other hand, they may be greatly exceeded, I do not know. I do know, however, that there are other rivers to control; that the technical problems connected with smaller structures may provide a test of engineering skill as challenging to the engineer as were those encountered in connection with either Boulder or Grand Coulee Dam, and that greater works undoubtedly lie ahead.

Conquering the Drought

Where? You may ask. Where now can a greater work be anticipated? Here in Nebraska; here in the Great Plains; right here in your own back yards.

Here in the Great Plains is presented the most difficult, the most challenging, perhaps the most important of all our conservation problems. You will have an opportunity to work at its solution.

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[1] Address delivered May 23, 1940, before engineering students of University of Nebraska, Lincoln, Nebr.

You understand the problem. A great strip of land reaching from Canada to Mexico, hundreds of miles wide, lies in the twilight zone between arid and humid climates. In some years it is wet enough to crop. In some years it is too dry. It once was covered with buffalo grass and was a magnificent pasture. Now, largely because of unwise use, much of it is without cover and subject to dust storms.

It is comparatively easy to cluck the tongue and say the Great Plains should never have been used so; that the Government should never have permitted this land to be divided into 160-acre homesteads and plowed; that the people who settled here should have adopted different land-use programs. That is an easy second guess, but it begs the question. This is 1940, not 1870. Our problem is one of correction now, not one of prevention as it might have been then. Our problem has been complicated a thousand times by what has happened in these 70 years; by the habits of thinking which have been established; by the waves of migration to and migration from the Great Plains. It has become an acute problem in social and economic adjustment and the lives and happiness of thousands of men and women and children are involved in it. No generality, however glittering, will suffice. No broad answer which is complete and satisfactory can be found. This problem must be worked out to meet the situations, human and physical, as they now exist.

Let us consider the physical aspects of this area. The land is gently sloping, cut by few watercourses. Except for the climate it might be a garden. The rainfall on the average approaches 20 inches annually. If this amount could be assured for the growing season, it would be sufficient for most crops. It cannot be counted upon, however, not even for each 12 months, let alone for any particular season of the year. Ten years may pass, such as those we have just experienced, in which the pen which records the rainfall may be almost continuously below the line which marks the average, and another decade may come when it will climb high on the graph and remain continuously above that average level.

The mistake which has been made, more than once, is the interpretation of a series of wet years as assurance of continuing rainfall. Hundreds of thousands of acres have been plowed and seeded in this belief. Towns have been built and homes insecurely established. This mistake should not be made again. Another wet period will come, just as surely as this long drought is here, but it will be followed by another drought.

Major readjustments must be made which will leave the population of the Great Plains secure through wet and through dry cycles. These readjustments can be made, partly through irrigation, partly through prudent use of such underground water as may exist here, partly through new or different land use practices. We have just witnessed the forced migration of nearly 100,000 families from this area. If the story should be dramatically told in our newspapers some morning of enforced abandonment of their homes by 100,000 families in far away Persia, the Nation would be in a sympathetic frenzy of grief. This drought has been so insidious in its tragic effects, however, that it has hardly stirred us. It has not galvanized us to action.

Government Agencies Cooperate

Some programs have been launched. There is, for example, the program of construction of small irrigation projects in the Great Plains through the joint efforts of the W. P. A., the Farm Security Administration, and the Bureau of Reclamation. These are small projects necessarily, since most of the streams in the Great Plains rise at low altitudes and are scarcely more reliable than the storms themselves. Some progress has been made in combining farm units into larger units so that a farm economy better adapted to low rainfall totals can be adopted. Some watering places for stock have been developed or improved. But we are far short of the goal.

To emphasize my next point, I would like to refer to an experience of the Bureau of Reclamation in the early days of its existence. Among the early irrigation projects we built were a few in the Great Plains, which were at that time comparatively dry. Hardly had those projects been completed when it rained again. Our law requires that the project works be paid for in fairly easy terms by the water users. The projects were abandoned. When the great drought of 1934 occurred, these works were wholly useless, since they had not been operated nor maintained. They would have paid for themselves several times over during this drought in crops saved and misery averted.

We are in a great drought period now. More irrigation projects are being built in this twilight zone between the humid East and the arid West. Other steps are being taken and proposed to bring about a permanent adjustment of man to his environment in the Great Plains. Will a few wet years cause these to be abandoned? Will another heedless wave of immigrants risk their futures in the area without the protection which sound planning and conservation can provide?

There is a great work to be done by you young people. It offers opportunity for professional employment, for intelligent application of your training and abilities, and for service. The Boulder Dam to be built here may be a thousand small dams; the All-American Canal may be hundreds of little ditches; the Lake Mead may be divided into many stock watering ponds, but you will be building a sound foundation for a new agricultural empire.

NEW T. V. A. REPORT

THE Bureau of Reclamation has received the following notice from the Tennessee Valley Authority, which it is glad to publish for its interested subscribers:

The Tennessee Valley Authority announces the recent publication of its Technical Report No. 1, The Norris Project. This report was prepared for the purpose of giving to the engineering profession the important and useful facts about the planning and construction of the Norris Dam and Reservoir. This, the first of a proposed series of TVA technical reports, contains 840 pages of text and 375 illustrations. To make the report of greatest use to those engaged on similar projects, relatively little space was devoted to parts of the work that followed well-established engineering practice, but novel or unprecedented features have been described and explained in considerable detail.

Among the topics covered in this report are: History of the Tennessee River development; the Norris project investigations; social and economic studies in the Norris Reservoir region; dam and powerhouse designs; access roads; employee housing; construction plant; river diversion; construction methods; analyses of construction costs; size of various construction crews; highway, railroad, and other adjustments made necessary by the creation of the reservoir; initial operations; unit costs; and total construction costs. The appendixes include a comprehensive statistical summary of the physical features of the project; copies of the engineering and geologic consultants' reports; details of the design, models, cement and aggregate studies; specification forms; allocation of project costs; TVA employee relationship policy and wage rates; and the Tennessee Valley Authority Act. The report also contains comprehensive bibliographies on each phase of the work.

Cloth bound copies may be procured from the Superintendent of Documents, Washington, D. C., at $1.50 each.

Cause of Decline in Crop Yields Studied on Nevada Projects

THE University of Nevada Extension Service has taken steps to institute planned rotation and fertilization schedules on several farms on the Truckee storage project, in an effort to learn the cause of the decline in yields, principally in alfalfa, and to eradicate pests and noxious weeds. These schedules at present will be confined largely to farms upon which farm account records are available. The comparison of future accounts with those of the past will be the most forceful argument in favor of the establishment of such schedules.

The Extension Service has actively distributed bulletins as an aid in preventing the ravages of cutworms and slugs in truck gardens.

Outlet Works at Grand Coulee Dam

By LLOYD V. FROAGE, *Assistant Engineer, Columbia Basin Project*

MANY years must pass before the principal purposes of the Grand Coulee Dam will be fully realized in irrigating about a million acres of arid land and supplying 8,000,000,000 kilowatt hours of electrical energy each year to homes and industries in the Pacific Northwest, but regulation of the flow of the Columbia River below the dam will be possible as soon as the dam is finished.

River Regulation

The Grand Coulee Dam will back up the Columbia River and raise its water surface 355 feet, forming a reservoir extending 151 miles to the Canadian border. By drawing down this reservoir a maximum of 80 feet, an active storage of 5,200,000 acre-feet of water will be made available for flood control, increasing power output, and for increasing river flow during seasons of low run-off. The minimum flow of the river may thus be increased from the present average of 25,000 to 40,000 second-feet. This increase in flow will make possible a large increase in the minimum power output generated at the Rock Island Dam and at any other power plants built hereafter on the Columbia above its juncture with the Snake River, and a lesser increase in the minimum low water power output at the Bonneville Dam, and at future plants between it and the Snake River. As Grand Coulee is the uppermost of the 10 dams in the proposed Columbia River development, and controls a large storage reservoir, all future power plants on the river may operate at increased capacity because of its ability to regulate stream flow.

The control of the river will also aid navigation during seasons of low run-off by increasing the minimum depth of water 3 to 4 feet upstream from the confluence with the Snake River, while below the Snake River the increase will be 2 to 3 feet. As a result of the ship locks at the Bonneville Dam, river transportation is developing rapidly on the lower Columbia River, and has increased 100 percent in the past few years. Barges having capacities up to 600,000 gallons are now hauling between 5 and 6 million gallons of gasoline per month as far as Kennewick, Wash. These barges at present are operated at partial capacity during the period of low water; but with the deeper water secured by river control, they will be enabled to operate at full capacity throughout the year.

For releasing water from the reservoir and aiding river control, there is being installed in the spillway section of the Grand Coulee Dam a system of outlet works consisting of 60 conduits, each 8½ feet in diameter. These conduits will not be used to release irrigation water as all water for irrigation will be pumped from the reservoir behind Grand Coulee up almost 300 feet into a balancing reservoir in the Grand Coulee, from which it will be distributed through a system of canals to the land to be served.

Gate frame section of 102-inch valve.

Outlet Conduits and Gates

Starting at elevation 934, the outlet conduits are arranged in three tiers, at vertical intervals of 100 feet. Each tier is composed of 10 pairs of conduits located in the odd numbered blocks from 43 to 63 with the exception of block 53. On the upstream face of each block is a semicircular trashrack structure 22 feet in radius and 250 feet in height, which affords protection to the conduits at all three elevations. Near the upstream end of each conduit are installed two gates in tandem, with a short section of conduit between. From the upstream face of the dam to a point 12 feet downstream from the downstream gates, the conduits are lined with heavily ribbed, semisteel castings 1¾ inches in thickness and 8½ feet in diameter. The upstream section of each lining is widely flared in a bell-mouth to provide a smooth entrance to the flow of water, and to prevent cavitation at the conduit entrance. The gate bodies also are heavily ribbed semisteel castings 1¾ inches thick. Each pair of gates at elevation 934 weighs 367,000 pounds. Conduit linings weighing 148,500 pounds bring the total weight per conduit to 515,500 pounds. The gates and semisteel conduit installations at elevations 1036 and 1136 will each weigh 397,000 pounds per conduit.

The gates are designed to operate at a maximum head of 250 feet. A maximum discharge of 265,000 second-feet will occur when all 60 gates are open, and the water surface in the reservoir is at elevation 1184. At greater reservoir elevations the lower gates will be closed. The two upper tiers will reach their maximum discharge of 210,000 second-feet when the reservoir is full at elevation 1,288.

Downstream from the cast-steel linings, the conduits at elevation 934 are unlined, but are heavily reinforced and descend through the mass concrete in a parabolic curve which emerges from the downstream face of the dam on a tangent to the curve of the bucket section of the spillway. At elevations 1036 and 1136, the conduits downstream from the gates will be lined throughout with welded plate steel five-eighths inch in thickness. Differing from the conduits at elevation 934, these conduits pass through the dam horizontally and, near the downstream face, turn sharply downward and emerge almost parallel to the downstream face of the spillway.

The gates and conduit liners for the outlet works at elevation 934 were manufactured by the Hardie-Tynes Manufacturing Co. at Birmingham, Ala., under specifications No. 701. Two types of gates are included in this specification. The upstream gate, known as the ring-follower type of gate, contains a long sliding leaf, through the lower portion of which is a cylindrical port that registers with the conduit, and provides a smooth channel through the valve body, when the valve is open. It is operated by oil pressure acting on a 30½-inch diameter piston. The ring-follower gate permits inspection of the downstream gate, known as the paradox type of gate, and is designed for emergency use in case the paradox gate becomes inoperative.

Gate Operation

The paradox gate is the service gate; and, to insure long life, is designed to operate without sliding friction. The leaf in some respects resembles that of the ring-follower gate. It consists of an upper, bulkhead section and a lower, ring-follower section, which, when the leaf is raised to the open position, forms through the gate a smooth cylindrical channel, coinciding with the walls of the conduit and minimizing resistence to the passage of water. Unlike the leaf of the ring-follower gate, there extends from the sides of the paradox leaf two diagonal flanges inclined with their top ends several inches downstream from their bottom ends. Between the diagonal flanges and the inner, downstream surface of the gate frame are assembled two long, steel wedges with their small ends upward.

The leaf is raised and lowered by a hoist mechanism consisting of two motor-driven screws which are attached through a common lifting beam to the upper ends of the two wedges. In raising the leaf to open the gate, the hoist mechanism draws the wedges in between the diagonal leaf flanges and the gate frame, thus forcing the leaf directly upstream away from its seat. This initial movement of the wedges causes the leaf to clear its seat by approximately three-sixteenths of an inch. The wedges and leaf then travel together as a unit to the upper or open position of the leaf. As a matter of refinement, the ends of the wedges are rounded off by the addition of semicircular heads 16½ inches in diameter. Each wedge assembly is enclosed in an endless chain of stainless-steel rollers, and resembles a caterpillar tread. These rollers travel on stainless-steel tracks or guides within the gate frame. A train of rollers is also installed between each wedge and the diagonal flange on the leaf, against which it bears. The wedges are thus enclosed on both sides by roller trains which reduce friction to a minimum.

Trashrack structures and conduit openings.

In closing the gate the leaf is lowered to the bottom limit of its travel. The leaf stops at this point, but the operation of the hoist continues until the wedges are retracted, allowing the leaf to be thrust horizontally against its seat by the pressure of water against its upstream face. When retracted the wedges and roller-chain assemblies are entirely free from load, as the pressure of water against the leaf is resisted entirely by the seat against which the leaf rests.

Immediately above each installation of the two pairs of gates is a gate chamber, housing the operating equipment and providing room for maintenance and repairs. The gate chambers of each tier are connected in series b galleries extending the length of the dam.

Upstream side of dam, showing outlet works, trashrack structures with lower set of trashracks in place.

Installation of Gates

On April 1, 1938, the Consolidated Builder Incorporated, the present contractors, bega installation of these gates. As maximu high water on the Columbia River occurs du ing the month of June, and it was probab that the river would overflow the gate bloc outs, there remained approximately 2 month in which to complete any work that wa started. The installation of gate bodies in s blocks seemed possible in the time available, s work was started immediately.

For supporting the gates in the blockout during assembly, the contractor made pede tals of structural steel. They were grouted i position with their top surfaces one-half inc below grade, allowing for shims and wedge with which to bring the gates to correct el vation. The gate bodies consist of three se tions known as lower bonnet, gate frame, an upper bonnet. As the bodies were not d signed to withstand full reservoir pressur the concrete placed around them was heavil reinforced with steel rings welded in the shap of ellipses. This steel was placed in bundle around the bonnets, for location after the gat bodies were bolted together.

The gate castings were delivered to th concrete placing trestle on flat cars, and wer transferred from the trestle to the gate block outs by two revolving cranes using a commo lifting yoke. As some of the assemblie weighed 39,000 pounds, this combination wa necessary, and it proved to be of advantage i the careful placing of castings.

In installing the gates, all flanged joint were cleaned, gaskets were cemented in place and flanges were given a coat of white lead just before they were assembled. The ring follower gates were the first to be installed After the lower bonnets and gate frames ha been assembled, they were adjusted for height by means of shims on the supporting pedes tals, so that the bores of the gate frame coincided with the bores of the conduit lining which had previously been embedded from th blockouts to the upstream face of the dam The gate frames of the ring-follower valve were next bolted to the projecting flanges o these embedded conduits, and lastly, the shor sections of lining, joining the ring-followe and paradox gates, were installed and bolte to the ring-follower gates. The lower bonnet and gate frames of the paradox gates wer next assembled, shimmed to correct elevation and bolted to the short sections of lining pro jecting from the ring-follower gates. The re maining conduit sections were next installe from the paradox gates to the downstrean walls of the blockouts. The placing and bolt ing down of the upper bonnets completed th assembly of the gate bodies.

The next item was the checking of the verti cal alignment throughout the entire length o the gate seats and stainless steel tracks. Fo this work, plumb bobs weighing 20 to 30 pounds were suspended with No. 6 music wire along the seats and tracks. Measurements taken with machinist's micrometers from the tracks and seats to the plumb wires showed any deviations from plumb. As the gate frames and embedded conduit linings were bolted together in continuous units, little could be done to change their alignment, so by means of screw jacks placed between the walls of the blockouts and the bonnet castings, the upper and lower bonnets were forced into alignment with the gate frames. This method of correction was so effective that, with few exceptions, the tracks and seats were brought within 0.015 inch of a true plane. Additional braces were placed around the bonnets to prevent their being shifted while concrete was placed around them. Jacks were also placed inside the bonnets to resist the hydrostatic pressure of the surrounding concrete which was poured in four lifts, one of which had a depth of 30 feet. Upon completing the embedment of the gate bodies in the six blocks, the summer flood was impending, so the upper bonnets were covered with wooden bulkheads to prevent floodwaters from pouring down through the gate bodies and bursting off the bulkheads on the downstream end of the conduits. Further work on the gates was suspended.

Following the period of high water, the installation of the gate bodies in the remaining four blocks was completed, and the installation of gate leaves and hoists was begun. The leaves for the paradox gates were the heaviest assemblies in the entire installation, weighing 53,300 pounds. In completing the assembly of the paradox gates, the leaves were lowered into place, and the hoists and upper bonnet covers were placed and bolted down. A manhole in each upper bonnet cover provided access for connecting the hoist stems to the leaves. As the upper bonnet covers of the ring-follower gates were without manholes, they were temporarily supported on blocks to provide access to the upper bonnets for connecting hoist stems and leaves. After installing the stems and lowering and bolting down the upper bonnets, the ring-follower installations were completed by slipping the hoist cylinders down over the pistons. The installation of the electrical and high-pressure oil systems for operating the gates was deferred until the gate chambers were covered over with concrete, and the galleries connecting the chambers were stripped of forms.

The diversion of the waters of the Columbia River at the Grand Coulee Dam was accom-

Grand Coulee Dam, with Coulee Dam, the Government town, in foreground.

plished, not by the use of diversion tunnels as on many projects, but by leaving certain rows of blocks through the dam at low elevations, thus forming channels or slots through which the river could flow. In the spillway section of the dam the even numbered rows of blocks were left low for this purpose. In the construction of the dam these blocks were handled in two groups differing in elevation by 15 feet. The river ordinarily flowed through the group at the lower elevation. As the pouring of concrete in the dam progressed, these low blocks were closed off one by one at their upstream ends by the placing of steel closure gates 52 feet in width and 35 feet high. By closing off the lower blocks so they could be filled with concrete, the river was forced to rise and flow through the next higher group. Thus the flow of water was diverted from side to side of the spillway, rising an additional 15 feet with each change.

When placing the closure gates, the contractor was directed to so regulate the rate of closing a gate that the flow of water would not be altered to such an extent that the water level downstream from the dam would be decreased in 24 hours more than 18 inches when the flow of the river exceeded 100,000 second-feet, 12 inches when the flow was between 60,000 and 100,000 second-feet, or 6 inches when the flow was less than 60,000 second-feet. In securing this result as much as 36 hours was spent in lowering a closure gate.

During the winter of 1938–39 the installation of the outlet works at elevation 934 was carried to completion. The concrete surfaces of the conduits were repaired and finished by stoning, the high pressure oil lines serving the ring-follower gates were installed, electrical installations were made, gate leaves were adjusted for proper travel, and all damaged painted surfaces were repaired. This work was completed and the first gate was placed in operation on May 2, 1939.

In placing a conduit in operation, the ring-follower gate was opened but the paradox gate was left closed. Water, under pressure from the contractor's water main, was used to fill the section of conduit extending from the paradox gate to the upstream face of the dam, and force off the wooden bulkhead which covered the upstream conduit entrance. The paradox gate was then opened, and the flow of water through the conduit dislodged the bulkhead from the downstream end. All gates were placed in operation by May 14, 1939.

With the outlet gates in operation, the placing of a closure gate became greatly simplified. When a closure gate was to be placed, an estimate was made of the flow of water in the diversion slot to be shut off; then, during the 24 hours preceding the placing of the gate, a succession of paradox gates would be closed at regular intervals until the resulting reduction in flow approximated that which would occur from the placing of the closure gate. Simultaneously with the lowering of the closure gate and the stoppage of flow through one of the low gaps, the recently closed group of paradox gates would be reopened, providing an alternate path for the water and maintaining the water level downstream. This procedure reduced the time required to lower a closure gate to a matter of only a few minutes, yet abrupt alterations of river flow approximated only that caused by the closing of one paradox gate.

On September 20, 1939, the last diversion slot was closed, and for the first time the entire flow of the river passed through the outlet gates. The water surface upstream from the dam on this date was at elevation 1024. This elevation was of particular advantage to the contractor in the use of a floating derrick, and was held fairly constant by closing outlet gates from time to time as the flow of the river decreased. During this same time, the installation of penstocks was in progress in the east powerhouse and penstock tunnels. The penstock sections were ferried across the east tailrace on a barge, and were lowered into the turbine pits by a floating derrick. Rough water in the tailrace resulted from waves set up by the discharge of the adjacent outlet conduits, and interfered with the handling of the penstock sections. Consequently, the outlet gates at the east end of the spillway were kept closed whenever the flow of the river permitted.

By the middle of October, the flow of the river had so decreased that it was being carried by 14 conduits. On October 26, at the approach of a flash flood, all 20 gates were opened and were left open 13 days while the flood passed.

When the outlet works at elevation 934 are in operation, the gates are very quiet. Operating at a head of 90 feet, and each discharging 3,500 second-feet of water, the gates do not indicate either by sound or vibration that they are in use. The ring-follower gates have at all times been left open, but each paradox gate has been opened and closed many times, each operation requiring about 8 minutes. During a brief period while opening or closing a gate, the flow of the water causes a snapping or crackling sound, but when the gates are fully open they operate so quietly that no sounds can be heard even when one inspects them by stopping his ears and holding a sounding rod in his teeth. It consequently becomes necessary to look at the indicator to tell whether a gate is open or closed. At the downstream end of the conduits, however, conditions are entirely different. The most violent turbulence replaces the calm and quiet of the gate chambers. The discharge from the conduits is too deeply submerged to be seen directly, but some appreciation of its force and magnitude may be obtained by watching the long row of billows leaping and boiling below the spillway.

During the working season of 1939, the installation of the second tier of outlet gates was carried practically to completion, and work on the third tier is now in progress, so it is probable that the third feature of the Grand Coulee project, river control, will become effective during the flood season of 1940.

Grand Coulee Dam Construction Progresses Rapidly

PRESENT construction progress at Grand Coulee Dam indicates the completion of concrete placement in 1941. The 5,000,000-yard mark has already been passed by the present construction contractor, bringing the total volume to 9,500,000 cubic yards—about three times Boulder Dam's bulk. Boulder is now the highest dam, but Grand Coulee, when complete, will be the largest concrete dam in the world.

A record average pour exceeding 10,000 yards a day is being maintained. The wing-dam actually the front wall of the pumping plant, to be built on the west side of the river, will be finished in August, and the dam-abutment sections will reach their maximum height of 110 feet by September.

Almost half of this year's concrete will be placed in the central 1,650-foot spillway section. Work in the spillway has to be timed against the annual flood flow of the Columbia River, which comes in June and July, with the peak usually late in June. At that time the river will flow through sixty 8½-foot tunnels in the center of the dam and over the tops of 17 columns of concrete blocks, which will have been left lower than their neighbors for that purpose. Thus, not only will the Columbia pass the dam without harm to incompleted parts, but it will create the spectacle of a 250-foot waterfall plunging down the spillway.

By the end of the year the spillway crest and bridge piers to support the highway across the top of the dam will be completed. Eleven drum gates, the 2,000,000-pound hydraulically controlled steel barriers, which will regulate the upper 28 feet of the reservoir behind the dam, will also have been installed by that time.

Grand Coulee Dam is the outstanding feature of the Columbia Basin project. It will furnish water to more than 1,000,000 acres of fertile lands and make available to the Pacific Northwest an abundant supply of low-cost electricity.

Grand Coulee Contracts Awarded

Three penstock coaster gates and hoists have been ordered for Grand Coulee Dam. To the American Bridge Co. of Denver was awarded the contract for one of the three coaster gates, on its low bid of $113,128; and to the Consolidated Steel Corporation, Ltd., of Los Angeles, was awarded the contract for furnishing three hydraulic hoists, on its low bid of $82,000. The penstocks are the huge pipes that convey river water to the turbines in the powerhouse for generation of electrical energy.

Embedded in the concrete of the Grand Coulee Dam will be eighteen 18-foot diameter penstocks for the main power units. The penstocks will be arranged parallel in two groups, nine for the right powerhouse and nine for the left powerhouse.

The three penstock coaster gates and hoists to be furnished under these contracts will be installed at the entrances of three of the main penstocks for the left, or west powerhouse, which is the only one being constructed at this time.

The penstock coaster gates act as guards, to be closed in emergencies in case of damage to the hydraulic turbines, or when it is necessary to unwater the penstocks to permit inspection and maintenance of the penstocks and turbines. Normally the gates will be opened and closed under conditions of balanced hydrostatic pressure on opposite sides of the gate leaves and with no flow through the penstocks, but under emergency conditions the gates may be closed with an unbalanced hydrostatic head of 245 feet on the upstream side of the gate leaves and with unrestricted flow through the penstocks.

The penstock coaster gates will be operated by these hydraulic hoists, using oil as a medium, with a maximum working pressure of 1,000 pounds per square inch in the hoist cylinders.

The contractors are required to deliver the equipment ordered as follows: one penstock coaster gate within 240 days, one within 285 days, and one within 330 days; one hydraulic hoist within 270 days, one within 315 days, and one within 360 days.

Joint Investigations, Columbia Basin Project

THE Grand Coulee Dam-Columbia Basin project will irrigate about 1,200,000 acres, an area roughly comparable in size to Delaware. This land, now dry and largely unused, will be highly productive after it is irrigated and when fully developed, perhaps in the next 50 years, will undoubtedly serve to support an increase of 500,000 in the population of the State of Washington.

Grand Coulee dam, the key structure of the whole Columbia River area, was begun in 1933 and will be virtually completed this year. In anticipation of the development of the irrigable lands, a law to prevent speculation was enacted several years ago. Under this law, no work was to be permitted on structures strictly assignable to the irrigation system pending completion of appraisals of the undeveloped land and the negotiation of contracts for the repayment of the cost of the project to be allocated to irrigation. Irrigation districts have been formed, the irrigable lands are being classified and appraised, and the repayment contracts are being drafted. It is anticipated that the terms of the anti-speculation law will have been met by this fall and that there will be no reason for further delay in the construction of irrigation features of the project provided that appropriations can be obtained next year.

Looking forward to the time in 1943 or 1944, when water may be available for the irrigation of the first block of lands under the project canals, the Bureau of Reclamation in July 1939 appointed Dr. Harlan H. Barrows, head of the Geography Department, University of Chicago, as planning consultant, and launched the joint investigations of the irrigation project. At the first meeting of the planning program in Spokane, Wash., a few months later, Commissioner John C. Page made the statement that the project area was like a blank sheet of paper and that the opportunity existed to sketch upon this sheet as nearly a perfect agricultural community as could be devised in advance.

Associated with Dr. Barrows are William E. Warne, director of information, Bureau of Reclamation, representative of the Washington office, and Dr. E. N. Torbert, economic geographer of the Bureau of Reclamation, who is field coordinator with headquarters at Ephrata, Wash., in the project area.

On November 1, 1939, Dr. Barrows and Mr. Warne drafted a plan for the joint investigations in which 28 separate problems, in addition to the basic engineering surveys, were set up for study. Participating in the studies in some capacity and to varying degrees are more than 30 agencies of the Federal, State, and local governments, educational institutions, private industry, and local civic organizations.

The objectives of the joint investigations are to provide a general plan for the development and settlement of the Columbia Basin area as a whole and detailed plans for areas to be irrigated relatively soon. The planning program has been superimposed on the usual topographic surveys and land classifications of the Bureau of Reclamation which here serve as a base. Subjects of study range from the number and proper location of new towns or cities within the area to suitable guides for ornamental and useful tree plantings on the individual farmsteads.

It is hoped that by adequate thought and foresight, many of the problems which might otherwise be encountered in the development of so large an area can be prevented from ever arising. It is recognized that the job of reclamation is not done when water is brought to the land, but is completed only when men have been enabled, as a result of such development to establish homes for their families, homes that are reasonably secure and adequate to the needs of American citizens. With this knowledge, while realizing also that the highest use of the Columbia Basin lands dictates that part of the new opportunities be extended to indigent but worthy farm families, the joint studies were begun.

Development Problems

For convenience, the problems of the investigation are divided into 16 divisions. The basic surveys, land classifications, and appraisers, together with a temperature rerecording program, constitute the first division. The second division is designed to provide information on applicable types of farm economy. The problems under this division seek information concerning types of crops, crop combinations, and crop rotations on other northwestern irrigation projects; the types of agricultural programs best suited to the project area; and practicable and equitable means, if any, to insure proper land use as determined.

Two investigations are included in the third division to determine the water requirements of the irrigable lands for the crop and land use programs recommended, and a study of ways of preventing excessive use of water.

The size of farm units is the subject of two studies in the next division, the first being a study designed to determine the optimum size of farm units, having in mind the type of crops and crop programs which are recommended, and the second designed to determine whether there is need for special "labor units" of small size to accommodate part-time farmers or part-time laborers.

Another division poses additional questions. Three problems are presented in the lay-out and equipment of farms: One, to delimit the sections where it may be desirable to arrange the farms in adjustment to topography; two, to determine feasible means to help insure an adequate standard of living and to minimize the financial commitments of needy families in providing suitable and essential improvements; and, three, the advantages, economic and social, in farm lay-out and farm work which might result from concentration of settlers in small communities or from grouping farm houses on corners of the farms.

Four problems related to the allocation of costs and to repayments are a study of the allocation of the costs of Grand Coulee Dam and the primary irrigation works; how equitable payments toward the cost of the primary irrigation works may best be secured directly or indirectly from nonrural settlers; whether it is desirable and practicable to assign different repayment charges against lands of different classifications; and what are the best means of extending financial aid in conservatively adequate amounts to needy settlers within the project area.

An investigation of methods for establishing the requisite control of privately owned lands, whether by Federal purchase or some other means, and a similar study related to the State, County, and railroad lands are included.

To estimate, in the light of all relevant factors, the annual rate at which lands should be brought in during the first few years after water becomes available is the assignment given to another group of investigators.

Division 9 is concerned with villages, and its problem is to determine the optimum number of new villages for the project area and their most advantageous placement.

Three problems related to roads and other transportation facilities are included, the first, to plan desirable additions to the road net; the second, to plan desirable additions to railroad facilities; and the third, to make a study of the significance to the project area of the Columbia River as a commercial route.

A study is being made of underground waters for the purpose of determining the best source of domestic water within the project area.

Division 12 contemplates a study of rural and village electrification.

Division 13 deals with manufactures, and its problem is to define the opportunities for village and neighborhood industries in the parts of the project apt to be settled relatively soon and to determine what steps should be taken to promote the development of industries of promise.

Recreational resources and needs are approached in an effort to locate and plan the lay-out and improvement of rural parks and recreational grounds within the project area, and to formulate plans to promote the recreational use of the great reservoir now forming above Grand Coulee Dam.

Division 15, involving rural community centers, is designed to plan the location and, as far as practicable, the improvement of sites for rural schools, churches, community halls, market centers, athletic fields, and the like.

The last division encompasses a study of governmental organization and public works programming and financing, the problem being to develop the most advantageous pattern of local governmental units to meet prospective public needs, having in mind the need to plan and finance the public improvements in such a way as to eliminate or minimize the possibility of an excessive tax burden.

With the Bureau of Reclamation, perhaps the key agencies cooperating in the joint investigations are the Washington State Planning Commission, the Pacific Northwest Regional Planning Commission, the Washington State College, and the Department of Agriculture through several of its bureaus.

Full and enthusiastic cooperation has been obtained from the railroads, the Chambers of Commerce, the Irrigation District Boards, the State Department of Conservation and Development, the Federal Housing Administration, the Corps of Engineers, the National Park Service, the Geological Survey, and many others.

Most of the groups designated for the study of individual problems have been organized and have their work under way. All the key studies which must report relatively soon are in progress.

The job of organization, as is indicated by the monthly reports issued by Dr. Torbert, is virtually completed. There seems to be every reason to hope and expect that the unprecedented preparation being made in advance for the settlement and development of the Columbia Basin area will result in the provision of means to increase the opportunities for success of every settler who casts his lot on the project, and the provision of opportunities for the maximum number of families, with or without independent means at the outset.

4-H Club Work on the Shoshone Reclamation Project

By FRANCIS A. CHISHOLM, *County Agent, Park County, Wyo.*

THE Shoshone project is one of the outstanding 4-H Club fields in Wyoming. Since the beginning of extension work 25 years ago, approximately 3,000 boys and girls have taken advantage of one or more years in some phase of the work.

The relationship of 4-H Club work to the farms and homes on the project has been of the highest quality, and has played an important part in the development of the entire community.

The "live at home" project, of which we hear so much today, has not been a serious problem here, largely because of the fact that over a period of years there has been an effective program of food conservation and preparation. Clothing problems have had the same attention and hundreds of potential homemakers have learned the practical application of the old and honorable art of sewing. This program, which has been carried on in the homes over a period of years, cannot but have a beneficial influence in the community.

Other phases of the 4-H homemaking program have held the interest of older girls from year to year to furnish a well-rounded course in training, not available from any other source.

Cleo Frisbie and Mary Ann Daley demonstrate on "Better School Lunches for Powell Project."

No less important are the effects of the agricultural program which has been carried by both boys and girls over the same period. The Extension Service has effectively used the club program to demonstrate practical farming operations. The introduction of purebred stock, the use of pure seed, and the importance of proper poultry practices, in addition to the valuable training received by the club members themselves, has had an inestimable influence on the progress of farming on the project.

In a new community one of the major problems has always been the lack of livestock. Cash crops have been the source of income to such an extent that the land has suffered. Realizing this, those who have had charge of shaping 4-H programs have made a special effort to encourage all types of livestock work.

In recent years, with the financial aid of the First National Bank at Powell, feeding operations for club members have shown a rapid increase. The bank has financed all phases of livestock feeding and the purchase of dairy stock, and to date has not lost a single account. As a result of this cooperation, the practicability of marketing home-grown feeds through stock has not only been a source of direct income, but has increased the productivity of the new farms by manufacturing cheap fertilizer so necessary with irrigation. This has been particularly true on the Willwood division, which has only recently celebrated its 10th birthday.

A conservative estimate of the monetary value of 4-H Club work to members in 1939 was $7,733.46.

Hallie June Cles and Helen Dellinger demonstrate and show "Clothes Closet Conveniences for the School and 4–H Girl."

Boys learning to caponize chickens.

During the past year 157 boys and girls on the Shoshone project took 4–H projects. The champion Angus baby beef at the Wyoming State Fair (this calf was Grand Champion at the Park County Fair), was fed by Harold Carter, Jr. Harold also won the grand championship showmanship contest at the junior livestock show at Billings, Mont., with a pure-bred Hampshire gilt. Wayne Pearson made an outstanding record with two fat calves, winning prizes at the county and State fairs and at the stock show in Billings. Carl Stine, a 4–H boy, has one of the finest herds of Hampshire hogs in Wyoming. He has supplied breeding stock not only over Park County, but over the State as well, as a result of his pig project.

Katie Gillett won the State bread-making contest in 1939 and received a trip to Chicago. These are only a few of the records made in 4–H Club work. Each year demonstration teams and individual champions are sent from this part of the county to the State fair, to Denver, and in one instance to Washington, D. C., as one of four outstanding club members in Wyoming in 1938. This was Doris Bender, of Powell.

The Extension Service is proud of the 4–H activities of the Shoshone project. It speaks well for the type of settlers who have made their homes here, as the success of the club work depends largely on the wholehearted cooperation of the parents.

Any account of progress made by organized effort is a tribute to the local leadership. To these volunteers who give freely of their time and talents without pay is due most of the credit for any success attained.

Activities of the Shoshone Chapter of Future Farmers of America

By HELEN L. WINDLE, *Senior, Powell High School, and Editor, Powell Powwow*

THE Powell Chapter of FFA on the Shoshone project was selected as the most outstanding chapter in Wyoming in 1939. The fact that out of the 39 Wyoming chapters the Powell group was chosen for this honor is in itself explanatory of the rating and reputation the boys have gained in agriculture in this and previous years.

Having 75 members on its roll, the order is only one of 10,000 chapters in the United States, with a total of 207,000 boys as members. The Future Farmers of America was formed during the American Royal of Kansas City in 1927, and includes boys of every State but Rhode Island, which has a law forbidding high school fraternities and that law precludes participation in the FFA. By the motto "Learning to do—Doing to learn—Earning to live—Living to serve" the order teaches leadership, thrift, character, service, improved agriculture, sportsmanship, cooperation, scholarship, recreation, patriotism, and citizenship.

Each boy has his individual projects every year, and an annual report as to the returns is made in the fall. In 1938–39 fifty-nine boys completed 93 supervised projects. The projects were worked in the following enterprises: Great Northern beans, pinto beans, sugar beets, beef cattle, sheep, hogs, dairy cattle, poultry, alfalfa hay, oats, barley, and corn.

The record showing the progress made in the past 3 years is here given.

1936–37	
Receipts	$16,404.60
Expenses	12,159.89
Net profit	4,244.71
Self labor	713.12
Total pupil labor income	4,957.83
1937–38	
Receipts	16,032.00
Expenses	11,869.97
Net profit	4,162.03
Self labor	845.81
Total pupil labor income	5,007.84
1938–39	
Receipts	26,889.43
Expenses	16,507.71
Net profit	10,182.72
Self labor	1,076.57
Total pupil labor income	11,259.29

In addition to the projects, the Shoshone Chapter has become known because of outstanding exhibits, livestock, and ability at judging.

The Powell Future Farmers won a great many prizes at the Wyoming State Fair in Douglas. They brought home the sweepstakes ribbon for the best exhibit and also the grand champion ribbon and two champion reserve ribbons for baby beef. The Powell FFA also won 47 blue ribbons, 33 red ribbons, 14 white ribbons, and two fourth-place ribbons for their entries. Their ribbons included awards for the school exhibit for vocational agriculture showing various phases of the work, best classroom notebooks, best display of grains, beets, potatoes, best steers, sheep, pigs, chickens, farm mechanics, and similar projects.

A livestock judging team from Powell attended the national stock judging contest in Kansas City. The boys on the dairy judging team were Sam Anderson, Mak Kawano, and Wilbur Reed. Members on the poultry judging team were Dennis Burch and Sam Anderson. These teams won the State judging contests earlier in the year, which enabled them to represent Wyoming at the national convention. C. N. Peterson, vocational agricultural teacher at Powell, and Verue Harrison, American farmer candidate from Wyoming, accompanied the boys. Verue Harrison was the American Farmer candidate, one being selected each year from the 1,000 Wyoming FFA boys. While at Kansas City, the Shoshone chapter received a cash prize for being of the greatest service to their com-

Three of Shoshone Chapter's best calves at Junior Fat Show. Left to right: Bill Franklin, Richard Schmidt, Wilbur Reed.

Left: Livestock judging team with cup won at Worland in feeder day contest.

munity, the judging team won fifth in Jersey cattle, and the certificate of American Farmer was given to Verne.

Powell boys won their share of victory and recognition at the second annual regional junior fat stock show at Billings, Mont. In the exhibit of fat livestock there were 424 Montana and Wyoming 4-H Club members and Future Farmers of America competing. The grand championship in the FFA showmanship division went to Richard Schmidt of Powell.

The State Future Farmers' judging contest was held at Laramie. There were 37 teams competing and the stock judging team from Powell placed third in dairy cattle. The poultry team placed second. Mak Kawano won third high individual honors. Dennis Burch also attended the contest and as State president of the FFA had the honor of being toastmaster at the banquet. Sam Anderson, also of Powell, is vice president of the organization.

Powell High School's FFA judges won both team and individual honors at the eleventh annual livestock judging contest conducted by the Worland, Wyo., chapter of FFA. The Powell judging team won first in the total judging for the day, while in individual judging, Brandt of Powell won first, and Miller of Powell, third.

The close of the annual Big Horn Basin livestock judging contest found Cody, Wyo., first and Powell second. Had the Powell boys won the contest this year, the cup which is given to the winner each year would have been in their permanent possession as they had won it the 2 years before, and need only 3 years of consecutive wins to keep the cup. Darwin Franklin of Powell was high individual, with Donald Jones of Powell, second.

With such an enviable record to back them up, C. N. Peterson and his FFA boys can be expected to do great things in the future, for themselves and for the farming community in which they live.

Machine Methods of Canal Lining

ROZA DIVISION, YAKIMA PROJECT

CONTINUED progress in development of more efficient methods and equipment warrants the belief that engineers and contractors will find special interest in a description of the equipment and methods used on contract construction for the Bureau of Reclamation on the Roza division of the Yakima project.

The year 1938 saw the completion of 13.9 miles of concrete-lined canal on the Roza division, almost all of which was lined by machine methods. The canal so constructed lies between the lower end of tunnel No. 1, which is 9 miles north and east of the city of Yakima, and the upper end of tunnel No. 5, approximately 3 miles south and east of the town of Moxee City.

The sections of lining between tunnels Nos. 1 and 3 have a bottom width of 14 feet, a depth of 13 feet, a water depth of 11.2 feet, and a carrying capacity of 2,200 cubic feet per second. Below tunnel No. 3, which extends through the ridge north of Yakima, the lined sections have a bottom width of 12 feet, a depth of 10.5 feet, a water depth of 9.07 feet, and a rated capacity of 1,300 second-feet. (Nine hundred second-feet will be used just below tunnel No. 3 in the generation of power for the pumping plants to be installed later.) The side slopes are 1¼ to 1, with an 8-inch concrete berm at the top of each. Five-foot earth berms were left when the excavation was completed.

The lining is 4 inches thick, reinforced with ½-inch round steel bars spaced at 12 inches longitudinally and at 24 inches transversely, the steel mat being approximately at the middle of the lining. Under the lining, and adjacent to the uphill slope, is a 6-inch drain tile surrounded by 3 inches of gravel.

The work under the first contract, comprising three sections between the siphon under the Yakima River, 6 miles north of Yakima, and tunnel No. 3, was done by J. A. Terteling & Sons. These sections total 2.4 miles in length. The second contract, which was awarded to the same company, extends 0.7 of a mile from the lower end of tunnel No. 1 to the bench flume which connects to the Pomona siphon. Lining under the third contract begins a short distance below tunnel No. 3 and consists of 3 sections, ending at station 1120+00. It was constructed by the H. J. Adler Construction Co. and comprises 1.6 miles of canal. The fourth contract, by Guthrie-McDougall Co. and Mark C. Walker & Son Co., extends from the above-mentioned station to tunnel No. 5, the lining being continuous for a distance of 8.9 miles. A section 100 feet in length below the siphon was constructed by hand methods by J. A. Terteling & Sons. Another short section above tunnel No. 3, built by Morrison-Knudsen Co., Inc., as a part of its tunnel work, is 0.2 of a mile in length and was lined by means of a small machine mentioned later in this article.

First Two Contracts

J. A. Terteling & Sons brought trimming and lining machines from an aqueduct in California and had them rebuilt to conform to the sections of the Roza Canal. Both machines operated on 18-inch-gage tracks of 30-pound rail, laid on the berms of the canal. The rails were in sections of varying lengths united by 6-inch steel-channel ties.

Trimming and compacting subgrade.—The trimming machine was a double trapezoidal steel truss suspended at each end on two hydraulic jacks supported by a four-wheeled truss having axles 10 feet apart. Scarifier teeth were provided along the front of the machine to trim the slopes roughly to line and grade. Behind the teeth on each slope was a long blade scraper to complete the process of fine grading. A V-shaped scraper trimmed the floor of the channel and moved the trimmings to bucket elevators which placed the spoil on a conveyor belt discharging onto the downhill berm. A sheepsfoot roller was used for compacting the floor. The trench for the underdrain was excavated by jackhammer and by hand. Considerable handwork was necessary to finish the grade preparatory to laying the reinforcement and placing the concrete. The soil was sprinkled to secure optimum absorption for compaction of the grade and to assist in curing the lining. The second contract by J. A. Terteling & Sons (specifications No. 711–1) was fine-graded by hand methods, the sheepsfoot roller being used on the bottom and air tampers, as found necessary, on the slopes. Wooden ribbons, 2 by 4 inches, were set to form the vertical sides of the concrete berms and served as positive guides for control of line and grade of the completed lining.

Concrete lining.—The slip form consisted primarily of a ¼-inch steel plate 6 feet wide, curved upward on the front and rear edges. The plate extended across the bottom and up each slope, there being a lag of 2 feet at the top. It formed the shorter base and sides of a regular trapezoid corresponding with the cross section of the canal. The deck of the machine formed the longer base, and the whole framework was trussed to form a complete jumbo. The jumbo rested on jacks supported by 4-wheeled trusses having 10-foot wheel bases. Horizontal plates attached to the sloping sides assisted in forming the concrete berms. The jacks permitted adjustment of the machine to grade, and thus compensated for some movement of the track.

The liner was advanced by means of cables operated by hoists driven by a gasoline motor. Alinement was maintained by the setting of the tracks and manipulation of the cables which were attached to the tracks ahead of the machine.

Concrete from the mixer on the lower berm was distributed by means of a gasoline-driven shuttle car operated across the deck of the liner. As the car moved across the machine the concrete was released through a bottom gate and slid down an inclined steel plate to the open-bottomed pockets along the front of the slip form. The pockets served to hold the concrete on the slopes and to feed the advancing form as it shaped the plastic material to the section of the canal.

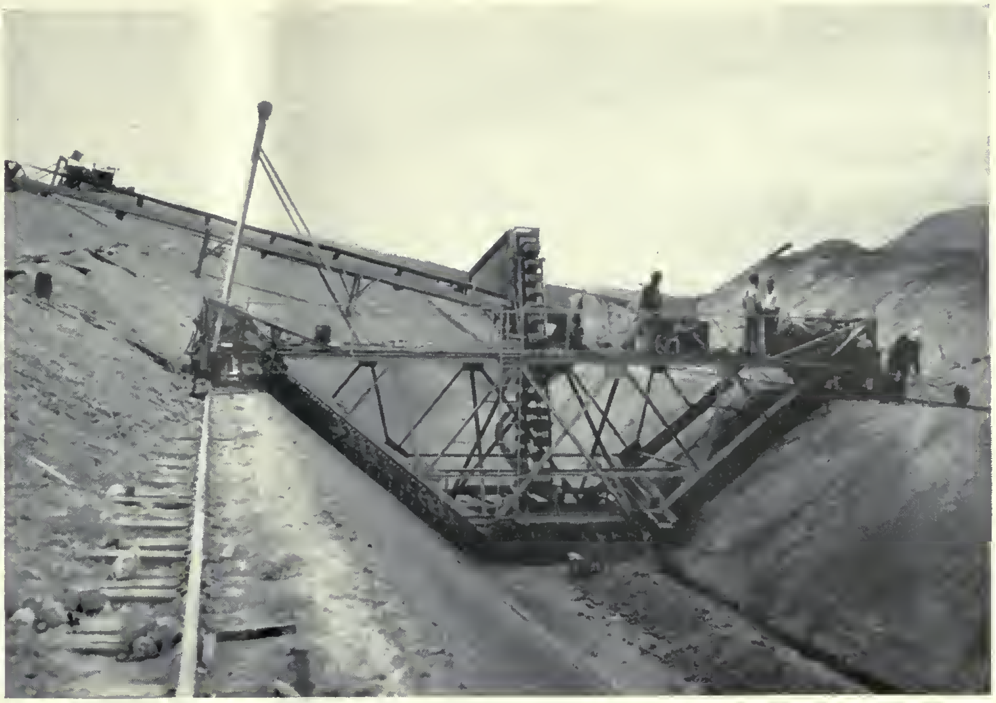


Photo 1: Trimming machine. Note rotating drum teeth, trimming arrangement, and screw-carrying device in canal invert.

A third motor operated 3-inch rotating rods extending down the slopes through the pockets. These rods, which had short fingers for working the concrete and to aid in feeding it to the form, oscillated about 60 times per minute through an arc of 90°. The fingers depressed the larger aggregate and lessened the work of the finishers.

A noticeable tremor in the whole machine from the vibration of the motor probably helped to compact the lining as the machine ironed it out. The weight of 40 tons assisted materially. (Practice has shown tube vibrators to be more effective than these oscillating rods.) The progress of the liner depended upon the rate of preparation of the subgrade. Using a 1 yard mixer, the aggregates being batched by truck and the cement by hand, it was possible to lay 425 linear feet of lining in an 8-hour shift.

Attached to the rear of the machine were stagings of plank which served the first group of finishers who used floats to remove the imperfections left by the moving form. Two wooden jumbos with plank steps for the other finishers followed. After these came the painters' jumbo equipped with a small air compressor and barrels from which coal-tar cutback curing compound was piped to the paint pot, whence hoses fed the guns used in applying the compound. Because of the distance traversed in the course of 14 days, and the windy climate, curing by water was deemed infeasible. Whitewash was used on the section of lining adjacent to tunnel No. 1 to prevent excessive absorption of heat by the black surface of the curing membrane.

Well-graded aggregates having a maximum size of 1½ inches were used in the concrete. A slump of 3 inches was found to be necessary for placing with this machine. Each night the lining was completed to a wooden header where it formed a vertical joint with the concrete lining placed in the succeeding day's run, the reinforcement being continuous through the joint. Drilled holes proved the lining to be well consolidated. Expansion joints were not used.

Third Contract (Specifications No. 729)

H. J. Adler Construction Co. constructed the lining in the section of canal below and adjacent to tunnel No. 3 (specifications No. 729) and designed and built trimming and lining equipment for its work.

Trimming and compacting subgrade.—The trimmer (photo No. 1) differed from the machine used upstream in that the cutting of the slopes was done by more than 400 teeth, seven-eighths inch square, attached to 12-inch revolving cylinders, the direction of rotation being opposite to that of the wheels carrying the machine on the rails.

The trimming machinery was supported on a trapezoidal steel truss which spanned the canal. Two-wheeled trusses, each with axle centers of 10 feet, carried the machine along tracks consisting of single 56-pound steel rails set at line and grade on wooden ties. A revolving spiral cutter-worm trimmed the bottom and moved the spoil to the central elevator which dumped it onto a belt conveyor for discharge to the lower berm. The machine was powered by three gasoline-driven motors; two operated the cutters on the slopes and moved the machine ahead by means of geared wheels on the tracks. The third operated the bottom trimmer, the elevator, and the conveyor. Jacks under the main frame of the trimmer allowed adjustment for grade. The machine advanced about about one foot per minute. A 10-ton roller and air tampers were used for compacting the bottom and the slopes. The ditch for the subdrain was excavated by hand and by pavement breakers. The steel was laid as described previously, concrete bricks being used for its support.

This trimmer produced a good subgrade in general, although the material to be removed varied in texture and required handwork in places. As much water as the subgrade would absorb was applied by hand sprinkling.

Concrete lining.—The lining machine was similar in principle to that used by J. A. Terteling & Sons, and modeled after it. The main plate, however, was only 3.5 feet wide, to prevent floating of the machine, which was lighter than the one used on the upper sections of the canal. Lack of proper design resulted in frequent break-downs in the operating machinery. The narrow plate made it less difficult to move the liner around the curves in the canal. Jacks in this machine permitted adjustment for grade as required. Wooden ribbons, as described previously, were used for the vertical sides of the berms and for control of the line and grade. Propulsion was by means of gasoline-driven drums with cables attached to the tracks ahead of the slip form. An endless cable shuttled the concrete car on the deck of the liner, the concrete being dropped through a bottom gate to the pockets. A slump of 3 inches was necessary for placement and working of the concrete handled through this equipment. The maximum daily run was 336 linear feet; the average 258 linear feet.

A staging on the rear of the machine, followed by wooden jumbos, provided supports for the finishers. A paint jumbo carried a small compressor and a supply of clear curing compound, of which three coats were applied. Here, as previously, curing by water was considered impracticable. The completed lining was of good quality.

Fourth Contract (Specifications No. 748)

Guthrie-McDougall Co. and Mark C. Walker & Son Co. used somewhat different methods and machinery on the 8.9 miles of lining above tunnel No. 5. The principal pieces of machinery, in order of their progress down the canal, were: The compacting machine built by this contractor; trimmer designed and built by Clyde Wood of Stockton, Calif.; a small conveyor for removing the drain excavation; wooden jumbos for handling tile, gravel, and steel; the lining machine designed and built, also, by Clyde Wood; and four wooden jumbos used by finishers and painters. All of these machines used under specifications No. 748 were moved on wheels which traversed the single 70-pound steel track laid on each berm. Three by 12-inch wooden ties spaced on 3-foot centers were used and pins through them minimized lateral movement. To maintain line and grade for the trimming and lining equipment, the tracks were set carefully to the line and grade of the canal.

Trimming and compacting subgrade.—The presence of cemented sand and gravel and "nigger heads" in the first 2 miles of this contract (specifications No. 748), necessitated overexcavation and refill with suitable material before the subgrade could be compacted and trimmed. Water was applied during this process and ahead of the lining operation so as to permit proper absorption into the grade.

The compacting machine (photo No. 2) consisted of an air-driven pile driver head of the type used for driving steel sheet piling. This driver was mounted on a carriage having pneumatic tires which traveled in top and bottom guide channels across the bottom and up the sloping sides of the canal. The driver carriage was moved by cables actuated by a gasoline motor, and the hammer by air from a compressor set on one end of the double truss.

The driver required a special foot and considerable experimenting was done before the best size and shape were determined. Finally, a steel plate, about 12 by 36 inches, with beveled edges, seemed to withstand the hammering and produce the best results. The rate of travel of the driver carriage was such as to allow some overlap in the travel of the hammer, which operated at about 90 blows per minute. Where special attention was required, as at berms and low spots, Ingersoll-Rand air tampers were used. Forward motion of the compacting equipment was by means of an air tugger and cables attached to the track.

The trimmer (photo No. 3) consisted of a traveling steel jumbo with a chain of cutting buckets running across the bottom and up each slope. The spoil was dumped onto the lower berm by a belt conveyor. Two gasoline motors operated the bucket lines and conveyors; a third operated a hoist which pulled the machine ahead by cables. The angle between the bottom and slopes was rounded by the transverse travel of the buckets. Hand compaction was used where necessary to complete the preparation of the grade ahead of the drain installation and steel-laying operations.

Concrete lining.—The type of lining machine (photo No. 4) used was developed on the Colorado River aqueduct in California. The sliding form in this case was 4 feet wide, with some lag at the upper ends of the sloping plates. The shuttle car received the concrete from the mixer and dropped it through a bottom gate to the inclined plate, from whence it was discharged into open-bottom pockets

Photo 2: Compacting machine operating at Station 1125, 8 miles east of Yakima. Hammer at left.

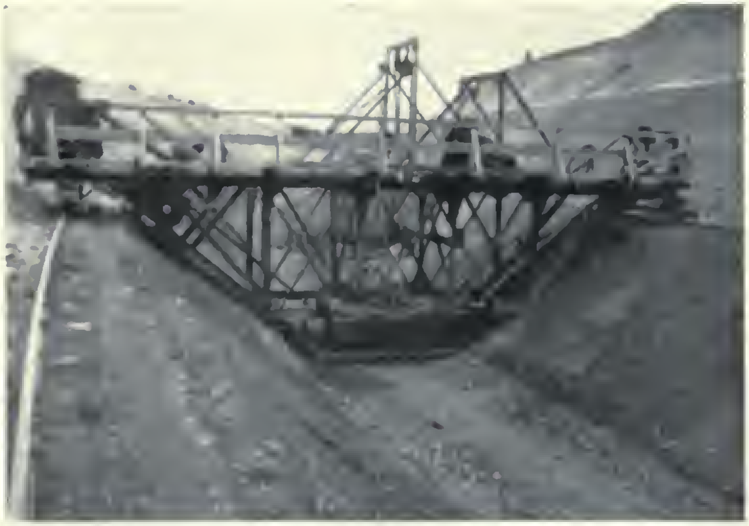
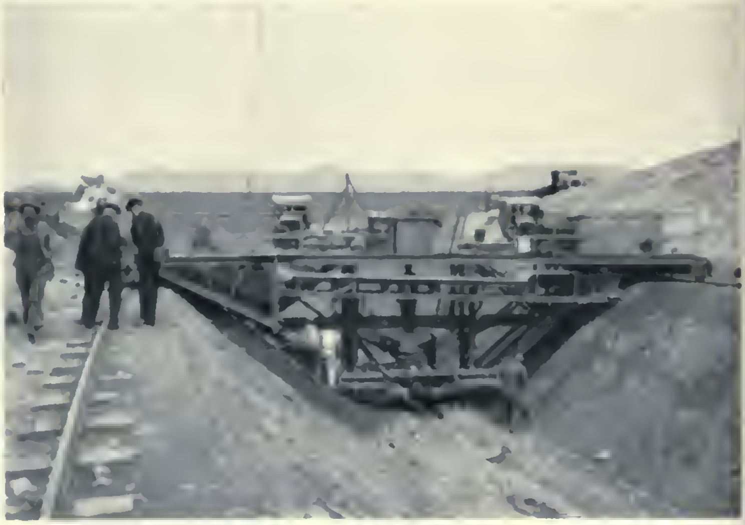


Photo 3: Canal trimming machine at Station 1124.



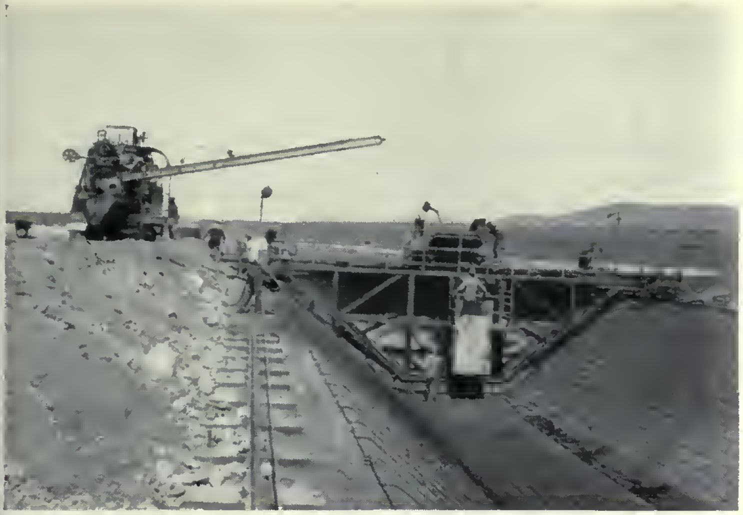


Photo 4: Lining machine in operation at Station 1141, 10 miles east of Yakima

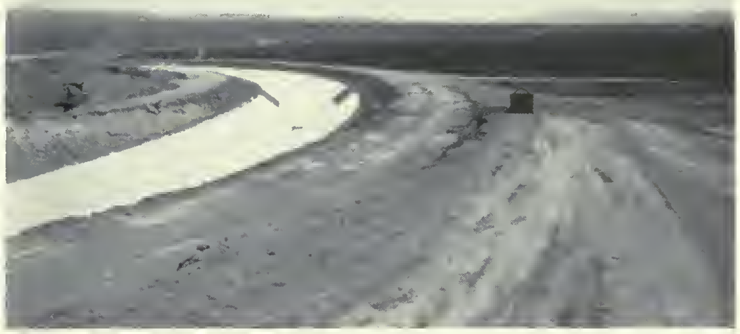


Photo 5: Lined canal. The concrete is first painted with coal-tar cut-back and then coated with whitewash as a temperature control. The dark patches on the lining are openings left for the piers of a bridge to be constructed.

along the front of the slip form. The rear edge of the main plate was placed near the center of the machine to facilitate movement around curves. Plates attached to the sloping side plates formed the tops and sides of the berms. The machine was carried on 2-wheeled trusses, the span between wheels being adjustable for movement on curves.

The method of placing and consolidating the lining differed from methods previously described. Tube vibrators extended through the pockets across the bottom and up each slope. The connections supporting the vibrators in the framework of the liner were provided with rubber pads to dampen vibration of the slip form. Electric motors operated the unbalanced shafts inside the tubes at 2,300 revolutions per minute. Extensive experimenting was done in connection with the determination of the proper amplitude for the vibrators. The use of these tube vibrators permitted satisfactory placement at a low slump—2 to 2½ inches. It was found advisable to operate the vibrators only as the machine advanced, as protracted vibration in one position actually "floated" the liner. Excellent consolidation was obtained with this equipment and the concrete was otherwise of good quality, as indicated by compressive strength test results as high as 5,600 pounds per square inch at 28 days.

Power for the machine was supplied by a gasoline-driven generator with push-button control from a panel on the front of the machine. Electric motors drove the concrete shuttle car and the vibrators, and pulled the machine ahead by means of cables. Progress varied with the rate of preparation of the grade and the production of concrete. The machine could be advanced 2 feet per minute, and as much as 120 feet of lining per hour was accomplished. Usually, the movement was intermittent, making the average somewhat less.

The 15 finishers worked from the staging attached to the rear of the slip form, and from the steps of the two jumbos which followed it. Those working on the berms used short sections of 2 by 4 to support the vertical faces of the concrete while floating and trowelling. It was planned to have special vibrators compact the berms as the machine advanced, but the manufacturer did not construct them soon enough. The finishing process for the bottom and slopes included floating and trowelling, hard trowelling being the final step. It was found that surface markings caused by springing of the reinforcement could be eliminated largely by trowelling upward at an angle of 45° and also longitudinally. Each night a wooden header was used to form a vertical joint at the end of the day's run. The steel mat was continuous, but the lining was scored five-eighths of an inch deep at intervals of 12 feet to control the location of contraction cracks.

Curing (photo No. 5) was accomplished by spray application of coal-tar cutback, followed by a sprayed covering of whitewash to prevent excessive heat absorption and consequent expansion of the concrete. The equipment for applying the tar was carried on one jumbo, and that for applying whitewash on a second jumbo. The tar was warmed in the early morning by piping the exhaust from the motor into a metal jacket surrounding the storage tank. Compressors driven by gasoline motors supplied air for the spray guns.

The tar was applied as soon as possible after the completion of the hard trowelling, and the whitewash as soon as the tar seemed hard enough to receive it without discoloration. Although whitewash containing about 7 percent casein glue had good adhesion, it was gradually removed by weathering.

The best run by Guthrie-McDougall and Walker was 821 linear feet in 8 hours. Such progress was possible only when all parts of the organization were "clicking." The average 8-hour run was 555.5 linear feet.

Under specifications No. 652 (extra work order No. 1), the 1,130-foot section of canal above tunnel No. 3 was trimmed by hand after the necessary compaction by sheepsfoot roller and air tampers. The drain and steel were laid as usual. Concrete for the floor was transported by bucket from the mixer, and spread and finished by hand. A step joint was provided at each edge of the floor, the joints being cleaned by wire brushing and water and air jets. As the concrete was placed at the foot of the slope, the joint faces were given a bonding coat of grout.

A jumbo was built by the contractor for lining the slopes. This consisted of a heavy framework carried by wheels which moved on wooden rails, one on the berm, the other at the foot of the slope. A steel plate, 10 feet long and 2 feet wide, served to form each panel of the lining as it was drawn up the slope by hand hoists. The concrete was consolidated by internal vibration. The slopes on curves were shaped to avoid flat surfaces. The berms were formed by hand. The finishing was done in the usual manner.

Under specifications No. 711–2 (extra work order No. 4), the 100-foot stretch of lining below the siphon was placed by hand, the floor being laid first, then the slopes.

As the lined canal constructed under these contracts has as yet no service record, the relative performance of the several sections, and of the work as a whole in comparison with other similar projects, has not been demonstrated. However, it is known that vibrators, especially those of the tube type used in the Wood machine, have permitted lower water-cement ratios than were possible otherwise, and the concrete placed by them has shown the highest density and compressive strengths. The superiority of tube vibrators for use in the mechanical construction of concrete canal lining has been proven.

Floating-Ring Gate and Glory-Hole Spillway at Owyhee Dam

By LEWIS G. SMITH, *Assistant Engineer, Denver Office*

ONE of the more interesting structures created in recent years by the Bureau of Reclamation is the glory-hole type spillway at Owyhee Dam in Oregon. Noted for its touch of originality, this spillway has, for its type, an unprecedented and to date unequaled height of 309 feet, with a 60-foot crest diameter. It has a 12-foot overflow controlling height, with steel-ring gate installed at the circular overflow weir. While the glory-hole type of spillway with lesser heights of fall had previously been used at several earlier dams, some having free crests and others having a number of radial gates between piers, the installation at Owyhee was the first and, to the knowledge of the Bureau, is yet the only instance in which a single gate controlling the full circle of the crest has been used (fig. 1). The ring gate is a hollow, annular drum, seated within a hydraulic chamber surrounding and in conjunction with the upper surfaces of the ring gate forming the spillway crest. It is raised or lowered as one complete unit by its own buoyancy in water introduced into the chamber from the reservoir.

At the time of installation the ring gate represented a bold departure from established practice. Many operating conditions had to be foreseen and provided for in making a foolproof design. Although the spillway and gate were completed in 1932, reservoir levels had not permitted them to be tested under actual operating conditions until four years later, in March 1936. Three years' performance of these have now been witnessed, making it possible to discover the degree to which the soundness of the designer's foresight has been confirmed. Often the hydrologic, topographic, and geologic conditions at a dam site form a triumvirate in economic favor of the glory-hole type of spillway, especially where a nonoverflow dam is to be built. Hence it is of live concern to disclose what experience has been gained from the Owyhee spillway. It is proposed to review here the reasons for selecting this type of spillway, the general design, construction, and performance of the spillway, with particular attention given to some of the more salient mechanical features of the ring gate, such as the means provided for keeping the gate level at all times; the method of automatic and hand control, with emergency safety measures; provisions for avoiding negative pressures at the inner lip of the gate; and the means adopted for preventing the formation of ice around the periphery of the crest.

The glory-hole intake structure of the spillway is located on a promontory on the north side of the reservoir and connects by means of a vertical, downwardly tapering, variable diameter shaft to a 22-foot diameter tunnel, used formerly for diversion of the river during construction of the dam (fig. 2). The total drop from intake crest to the tunnel is, as stated, 309 feet, or 14 feet higher than the dome of the United States Capitol Building in Washington, D. C. Immediately upstream from the junction of the vertical shaft with the horizontal tunnel is a plug of concrete for sealing off the reservoir at the tunnel elevation.

The ring gate at the crest is provided so that, during normal inflows to the reservoir the gate can be raised, preventing spilling of the water and allowing it to be conserved in the reservoir storage space above the spillway crest; then, during high run-off, after the reservoir is already full, to be lowered so as to waste water through the spillway rather than allow it to overtop the dam. As the flood recedes the gate will again be raised according to the reservoir levels so that no more water than necessary is wasted. Within a certain range of reservoir levels the normal operation of the gate is automatic, but hand controls are provided so that the gate may remain in the lowered position should this be desirable. A single gate, instead of a number of gates between piers, was chosen because with the single gate the diameter of the crest could be considerably smaller in achieving the same discharge capacity.

The glory-hole type of spillway was selected after much weighing of facts, theory, and judgment. Because of plans to build in the future a power plant near the foot of the dam, and in view of the confining character of the canyon walls, an overflow crest section in the dam was excluded, giving way to some type of appurtenant spillway leading around the dam. An open-channel spillway would have required large amounts of rock excavation because the canyon walls continue in an abrupt ascent above the crest level of the dam. A tunnel type of spillway chute therefore seemed to present the more favorable solution of the wasteway. Of the common types of intake structure used in combination with a tunnel chute, such as the side channel as at Boulder Dam, the straight approach as at Seminoe, and the glory hole, the last named proved to offer a substantial saving over the others. A diversion tunnel was required in any event because of the scarcity of working area in the bottom of the canyon and the presence of a fault 113 feet deep to be mined and backfilled with concrete. The less expensive connection between

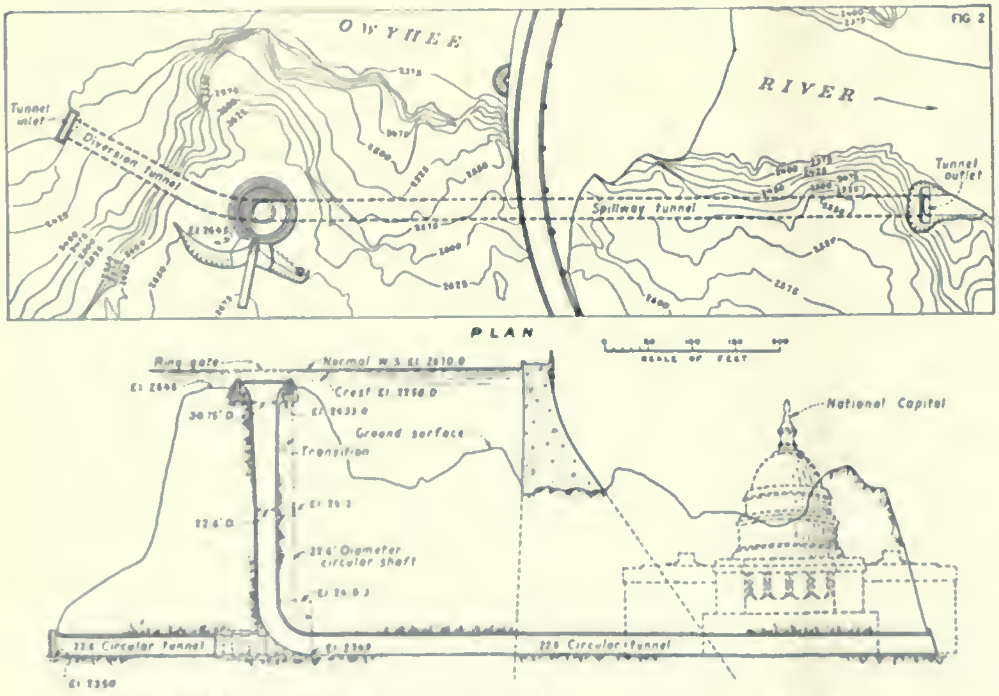


FIG 2

PLAN

LONGITUDINAL SECTION THRU DIVERSION TUNNEL AND SPILLWAY

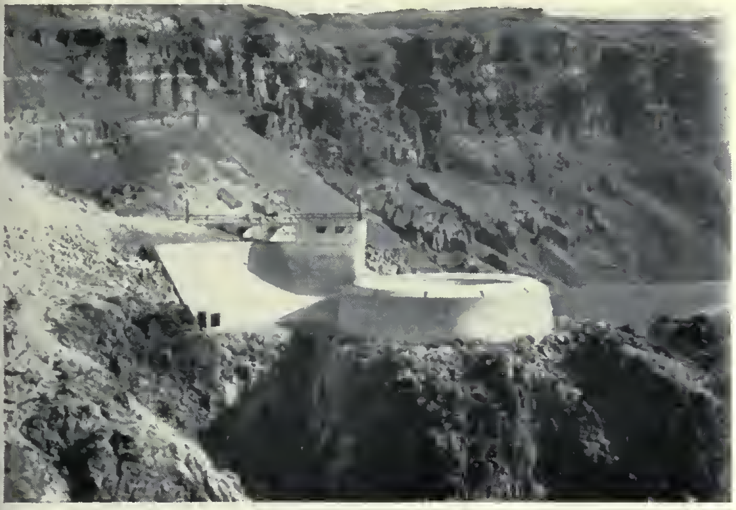


Figure 1. Crest structure for glory-hole spillway during filling of reservoir.

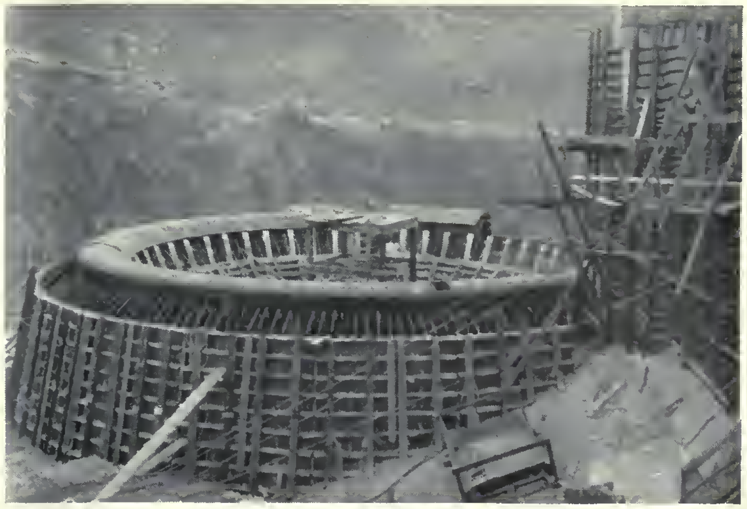


Figure 3. Crest structure during construction.

the spillway intake structure and the diversion tunnel was, according to the most fundamental theorem in geometry, a vertical drop. It can be seen from figure 2 that the promontory on which the crest structure is located was ideal for the type of spillway selected. Comparatively little excavation was required for the crest structure and the shaft. Even though an inclined shaft with some other type of intake had been selected, the hydraulic problems arising from the jet falling within a closed conduit with consequent entrainment of air would have been similar though perhaps not identical to those prevailing with the vertical shaft. Hence, almost every consideration seemed to emphasize the desirability of the glory-hole type, and it was therefore chosen.

Crest Structure

The intake structure, made of reinforced concrete, is comprised of the circular crest with an adjoining control chamber and pier on the landward side, as shown in figure 2. The circular crest structure contains the ring-gate hydraulic chamber which is 7.5 feet in maximum width with a mean diameter of 60 feet and an approximate depth of 16 feet. For seating the gate in its lowered position, 12 concrete pedestals 18 inches high are constructed at the flooring at 30° spacings of the circle. Water for floating the gate into raised positions is supplied through an inlet pipe protected by a trash-rack structure located approximately 60 feet downstream from the control pier. The nose of the control pier was placed radially adjacent to the circular crest at the side closest to the shore so as to avoid swirl or whirling vortex action of the water as it overflowed the crest. The figures showing the spillway in action illustrate clearly the radially converging inward flow proving that no swirl or vortex motion is present.

In order to prevent negative pressures where the inner lip of the ring gate protrudes over the inner lip of the hydraulic chamber, an air duct extending the full circuit of the structure is formed on the inward side, with 8-inch pipes leading from the ceiling of the duct to the top of the lip. The air duct connects with the air shaft in the forepart of the control pier. On preliminary designs it had been planned to feed this air shaft through a floor grating at the top of the pier. Later it was seen that this would constitute a grave hazard to the safety of visitors standing on the top of the pier as the heavy down draft of high velocity might tend to draw them against the inlet grating and crush them. In avoiding the possibility of such occurrences, the air-intake openings were placed in the sides of the pier. Subsequently, however, the luring fascination of the water swiftly pouring into the dark abyss in so spectacular a fashion proved to be so strong an attraction to the first visitors that they swarmed out on the pier nose and stood up on the railings, the better to see this strange phenomenon, and took so many risks in satisfying the urge to look down into this entrance to a modern version of Dante's descent into the infernal regions that it became necessary to enclose the pier in heavy woven fencing and so prevent visitors, for their own safety, from gaining access to it.

In order to prevent the formation of ice near the spillway crest, which formation might otherwise hinder the operation of the gate during periods of nonoverflow, a system of compressed air outlets is provided. Air pipes extend to the top of the outer lip of the crest structure at 4-foot intervals. With air bubbling through at these points, warm water is brought up from below in the vicinity of the gate and is kept sufficiently agitated to prevent its freezing.

The inner and outer lips of the hydraulic chamber were reinforced both circumferentially and radially, with care being exercised to balance the reinforcement of these two systems. The forming of the bell-shaped surface of the inner lip required expert carpentry, and resulted in one of the most perfect curved-surface jobs the Bureau has known. Forms for this section were made of matched ¾- by 4-inch facing and were constructed en bloc at the carpenters' shed, then cut for placing. Metal-lined panel forms were used in the cylindrical portions below, where concrete was placed in 10-foot lifts. Concrete was delivered to a loading hopper from the mixing plant and from the hopper to the forms by a 1-yard, bottom-gate bucket on a 90-foot boom of a derrick located midway between the hopper and the shaft. The ring gate was placed in position before the upper tips of the crest structure were poured, as shown in figure 3.

Ring Gate

The ring gate was fabricated in 12 circular erecting segments, each being 16 feet 9$\frac{1}{16}$ inches in length, as shown in figure 4. It is an assemblage of wall, roof, and bottom plates ⅜-inch thick, laced vertically at 16-foot 9$\frac{1}{16}$-inch intervals constituting the vertical joints between segments, as shown in section BB, and braced horizontally at six intermediate planes as shown in the plan view and in the section AA. Each segment has a field splice about midway the height of the gate as shown in section AA. This splice was imposed by transportation limitations. Erecting segments were joined with field rivets through end stiffeners of adjacent segments, and abutting skin plates were field-welded and ground smooth. Seating shoes, consisting of short pieces of 21-inch I beams, are bolted to the bottom skin plate on each side of the field joint. These shoes rest on the 12 concrete pedestals previously mentioned, as may be seen in sections B–B and D–D, figure 5.

The lip at the top of the gate, being curved in two dimensions, required that the top plates be scalloped in conformity with best shop practice in vogue at the time of construction. Subsequently, improvements have been made in plate-shop technique so that now it is possible to have the plates pressed with the desired curvings without undue difficulty of shop fabrication or marked variation in thickness of the plate.

One of the most difficult matters which had to be faced in the ring gate was the problem of keeping the gate level, even though a large amount of trash, logs, or ice become snared at one side. In meeting this problem an arrangement was devised which makes it physically impossible for one side of the gate to be appreciably higher than the other. This device is illustrated in figure 5. Each gate shoe, previously mentioned, is equipped at the bottom with two bearing brackets which support 3$^{15}/_{16}$-inch diameter shafts extending in both directions circumferentially to the shoe next removed. These shafts have geared rack wheels keyed at each end. The twin track wheels at each shoe mesh with vertical gear racks anchored to the concrete wall of the chamber. With this arrangement, any vertical movement at one shoe is simultaneously transmitted by rotation of the shafts to the two adjacent shoes and so on around the entire circumference of the gate. The only opportunity for lag between one side of the gate and the other arises either from twist in the shafts or from play between the gears of the wheels and the gears of the racks. In order to minimize the latter possibility the gears were accurately machined. As for twist in the shafts, the amount to be produced on a 3$^{15}/_{16}$-inch diameter cold-steel rod, with the torques as exerted, is exceedingly small. Each year the gear racks and leveling device are cleaned and coated with a waterproof grease. Flanges on the gear-rack wheels prevent the gate from rotating in the chamber. See enlarged section at "A," figure 5. Two guide-rollers are placed at each 30-degree point on the circumference at the top on the outside of the gate for preventing any tendency of the gate to jog laterally.

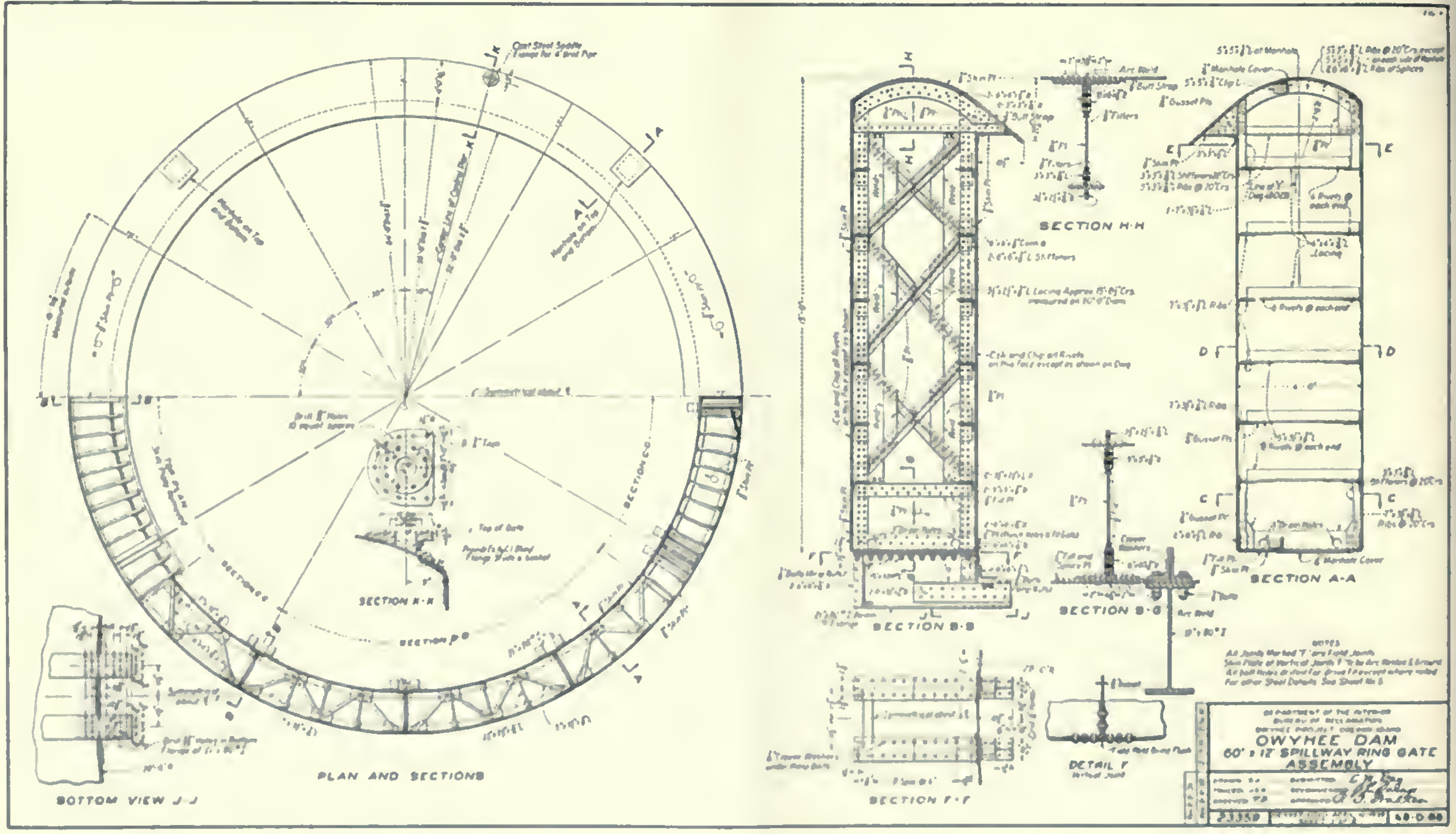
Spring-type metal seals are provided at the inner and outer lips of the hydraulic chamber, and are arranged so that the seal on the inner side prevents the escaping of water from the hydraulic chamber, and the seal on the outer side prevents entrance of reservoir water into the chamber at this point. These seals improve the functioning of the gate when it is in the raised or nearly raised positions; however, the performance of the gate in this position is not wholly dependent upon the effectiveness of the seals. The manner of operation is such that the gate will function even though all seals should become totally ineffective.

The gate is raised, as stated, by its buoyancy in displaced water; hence, any appreciable amounts of leakage into the interior of the ring gate would impair its operation. It was necessary therefore to provide internal drainage of the gate. These drains, shown in section "G–G," figure 6, were placed at four equal intervals around the circumference. Flexible-jointed piping was installed between the gate connection and the drain outlet connection in the floor of the hydraulic chamber. Each year the drains are taken apart and cleaned to make sure that all swinging joints are free and not fouled by rust.

During installation of the gate some difficulty was experienced in making the field splices at the midsections of erecting segments caused by bending and warping of the walls while in transit. From this experience it was concluded that the splices might better have been placed at one of the planes of horizontal ring-rib bracing which could have been arranged to provide support for both halves of the segment at the plane of joining. After installation the gate was tested by floating it to a raised position as shown in figure 7.

Gate Controls

Operation of the ring gate is similar in general principle to that of the conventional drum gates such as are installed at the spillways at Boulder dam and are to be installed at the overflow crests of Grand Coulee and Shasta Dams. There are two general phases of gate operation; the first, in which the gate is caused to rise in advance of a rising reservoir by means of water communicated directly to the hydraulic chamber from the reservoir, with the elevation of the water surface within the chamber being the same as the elevation of the reservoir surface; and the second phase, in which either the automatic or hand controls are brought into play in a manner as to disturb the balance of water surface levels



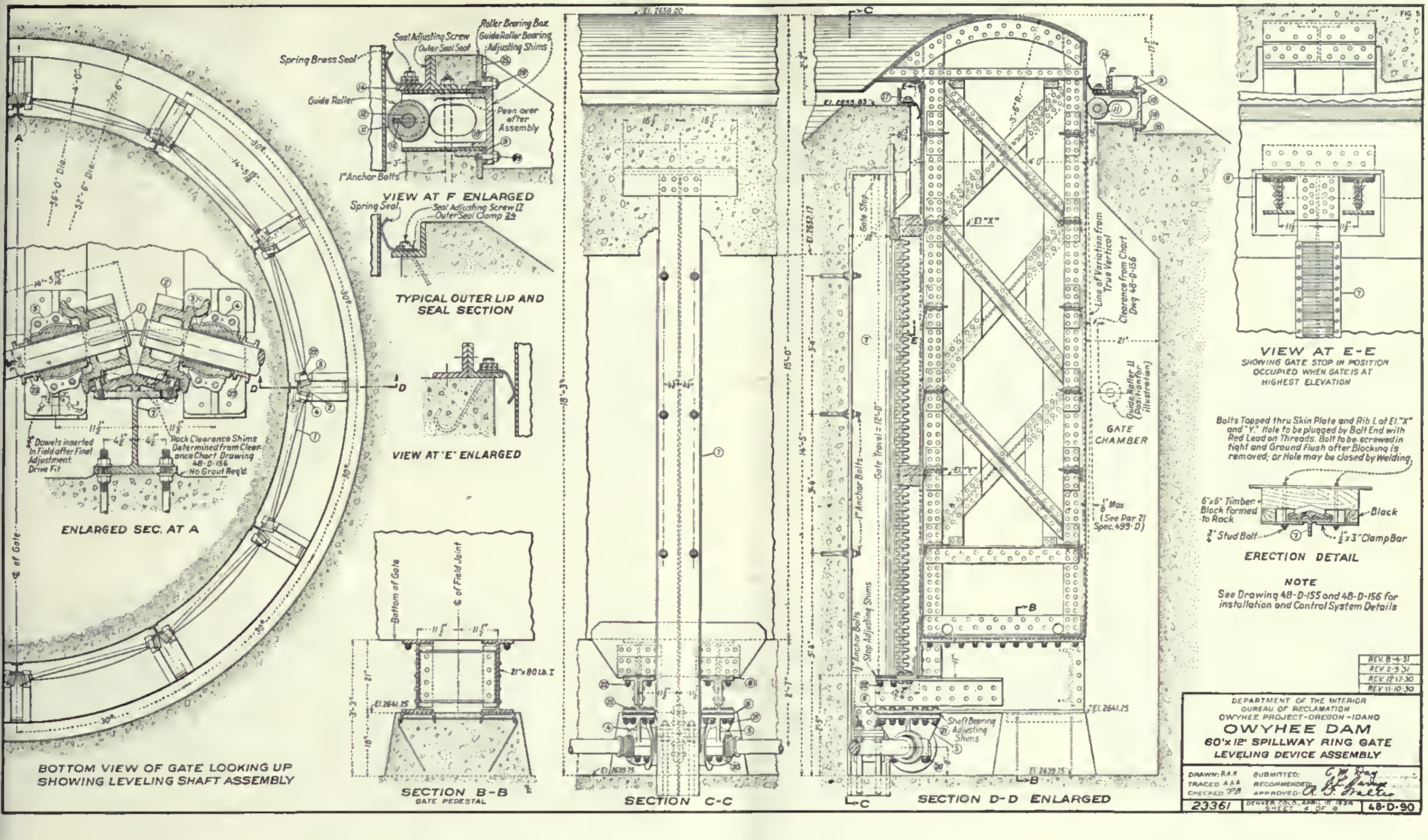


FIG. 5
Spring Brass Seal
Seal Adjusting Screw
Outer Seal Seat
Roller Bearing Box
Guide Roller Bearing
Adjusting Shims
Guide Roller
Peen over after Assembly
1" Anchor Bolts
VIEW AT F ENLARGED
Spring Seal
Seal Adjusting Screw 12
Outer Seal Clamp 24
TYPICAL OUTER LIP AND SEAL SECTION
VIEW AT 'E' ENLARGED
56'-0" Dia.
52'-6" Dia.
Dowels inserted in Field after Final Adjustment. Drive Fit
Pack Clearance Shims Determined from Clearance Chart Drawing 48-D-156. No Grout Req'd.
ENLARGED SEC. AT A
℄ of Gate
BOTTOM VIEW OF GATE LOOKING UP SHOWING LEVELING SHAFT ASSEMBLY
Bottom of Gate
℄ of Field Joint
21" x 80 Lb. I
El. 2641.25
SECTION B-B
GATE PEDESTAL
El. 2658.00
El. 2639.75
SECTION C-C
El. "X"
El. "Y"
Gate Stop
1" Anchor Bolts
Gate Travel = 12'-0"
Stop Adjusting Shims
Line of Variation from True Vertical
Clearance From Chart Dwg 48-D-156
Guide Roller 11 (Position for illustration)
GATE CHAMBER
1/8" Max (See Par 21 Spec. 499-D)
Shaft Bearing Adjusting Shims
El. 2641.25
El. 2639.75
SECTION D-D ENLARGED
VIEW AT E-E
SHOWING GATE STOP IN POSITION OCCUPIED WHEN GATE IS AT HIGHEST ELEVATION
Bolts Tapped thru Skin Plate and Rib L at El. "X" and "Y". Hole to be plugged by Bolt End with Red Lead on Threads. Bolt to be screwed in tight and Ground Flush after Blocking is removed; or Hole may be closed by Welding.
6"x6" Timber Block formed to Rock
Block
Stud Bolt
3"x3" Clamp Bar
ERECTION DETAIL
NOTE
See Drawing 48-D-155 and 48-D-156 for installation and Control System Details
REV. 8-4-31
REV 2-9-31
REV 12-17-30
REV 11-10-30
DEPARTMENT OF THE INTERIOR
BUREAU OF RECLAMATION
OWYHEE PROJECT-OREGON-IDAHO
OWYHEE DAM
60'x12' SPILLWAY RING GATE
LEVELING DEVICE ASSEMBLY
DRAWN: R.A.R.
TRACED A.A.A.
CHECKED P.B.
SUBMITTED: C. M. Day
RECOMMENDED:
APPROVED: A. B. Walter
23361
DENVER COLO., APRIL 18 1929
SHEET 4 OF 6
48-D-90

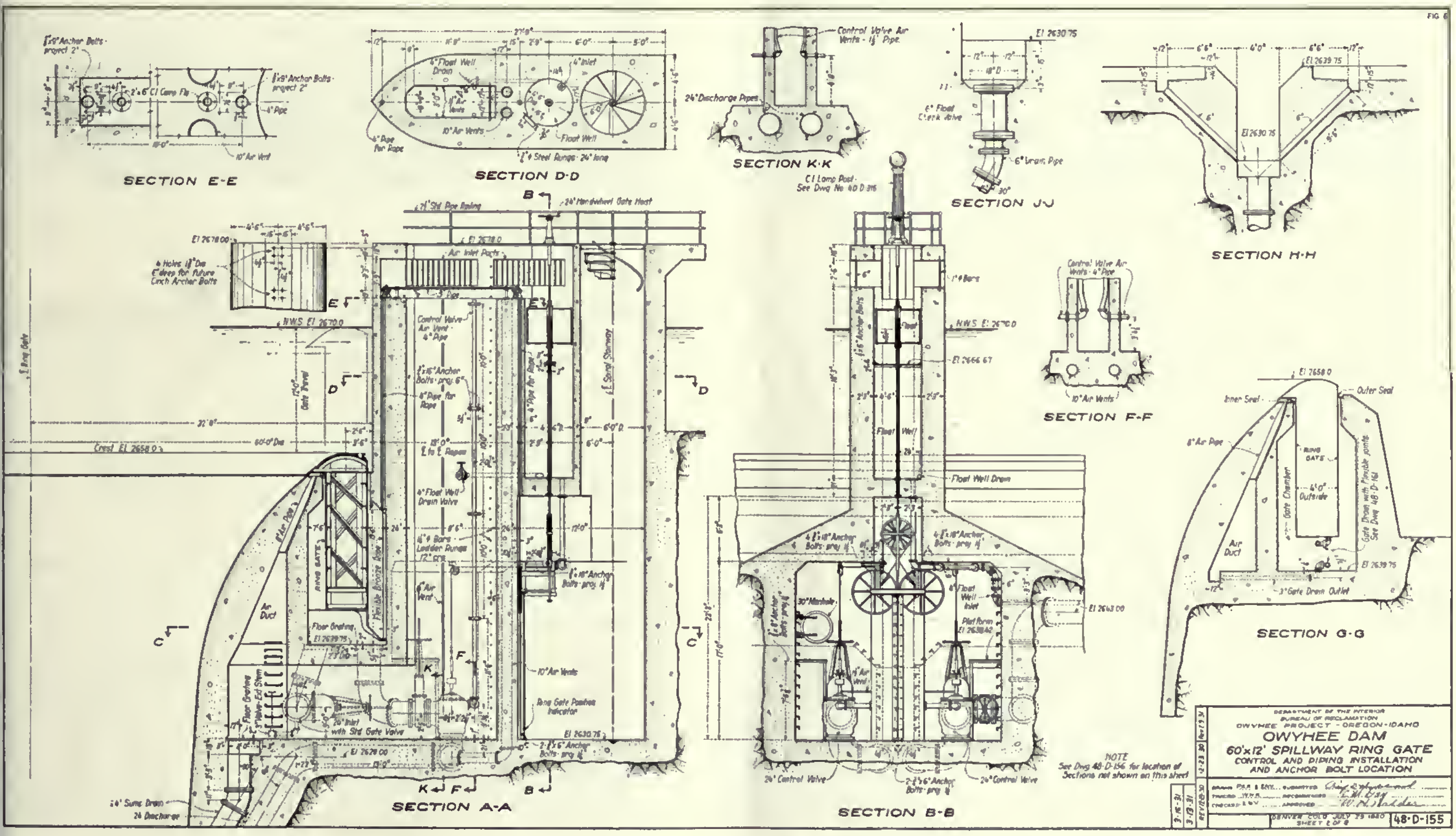


FIG. 6
Anchor Bolts project 2"
C.I. Cover Pl.
4" Pipe
10" Air Vent
SECTION E-E
4" Float Well Drain
4" Inlet
10" Air Vents
Float Well
24" Discharge Pipes
Steel Rungs - 24" long
SECTION D-D
Control Valve Air Vents - 1½" Pipe
SECTION K-K
El. 2630.75
6" Float Check Valve
6" Drain Pipe
SECTION J-J
El. 2639.75
El. 2630.75
SECTION H-H
C.I. Lamp Post. See Dwg. No. 40-D-316
Std. Pipe Railing
24" Handwheel Gate Hoist
El. 2678.00
El. 2678.0
Air Inlet Ports
N.W.S. El. 2670.0
Control Valve Air Vent - 4" Pipe
4" Pipe for Rope
Spiral Stairway
Crest El. 2658.0
60'-0" Dia.
4" Float Well Drain Valve
Ladder Rungs
6" Air Vent
Floor Grating El. 2639.75
Air Duct
Ring Gate
10" Air Vents
Ring Gate Position Indicator
El. 2630.75
El. 2629.00
24" Discharge
Sump Drain
SECTION A-A
Control Valve Air Vents - 4" Pipe
10" Air Vents
SECTION F-F
N.W.S. El. 2670.0
El. 2666.67
Float Well
Float Well Drain
30" Manhole
Float Well Inlet
Platform El. 2638.42
El. 2643.00
24" Control Valve
24" Control Valve
SECTION B-B
El. 2658.0
Inner Seal
Outer Seal
8" Air Pipe
Ring Gate
Gate Chamber
Air Duct
El. 2639.75
3" Gate Drain Outlet
SECTION G-G
NOTE
See Dwg. 48-D-156 for location of Sections not shown on this sheet
DEPARTMENT OF THE INTERIOR
BUREAU OF RECLAMATION
OWYHEE PROJECT - OREGON - IDAHO
OWYHEE DAM
60'x12' SPILLWAY RING GATE
CONTROL AND PIPING INSTALLATION
AND ANCHOR BOLT LOCATION
C. M. Day
W. H. Nalder
DENVER COLO. JULY 23 1930
SHEET 2 OF 6
48-D-155

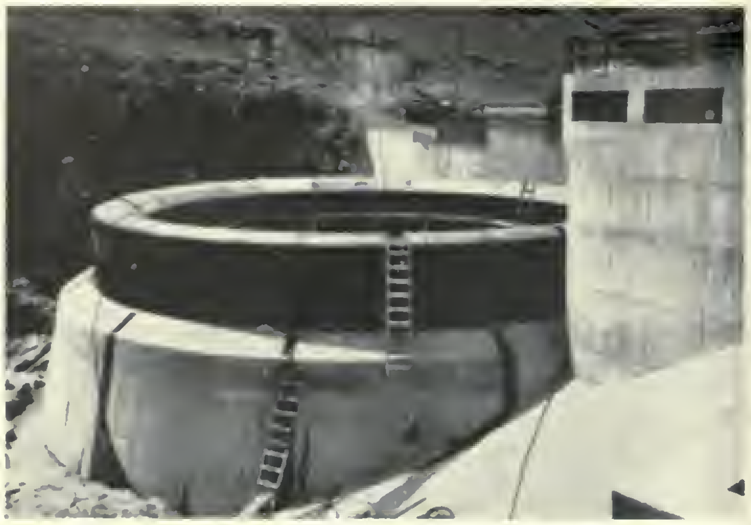


Figure 7. Ring gate floated to raised position during test.

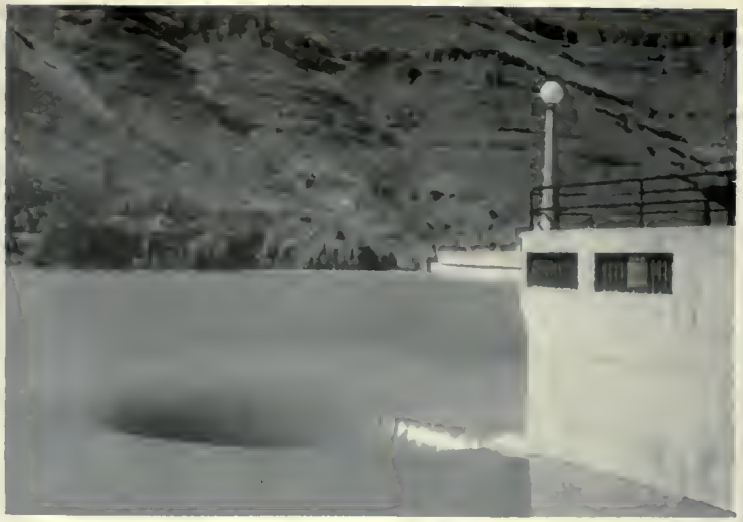


Figure 9. The glassy smoothness of the rapidly flowing water, $2^{1}/_{2}$ feet deep over crest shown in this picture, as it starts its 300-foot plunge, is remarkable.

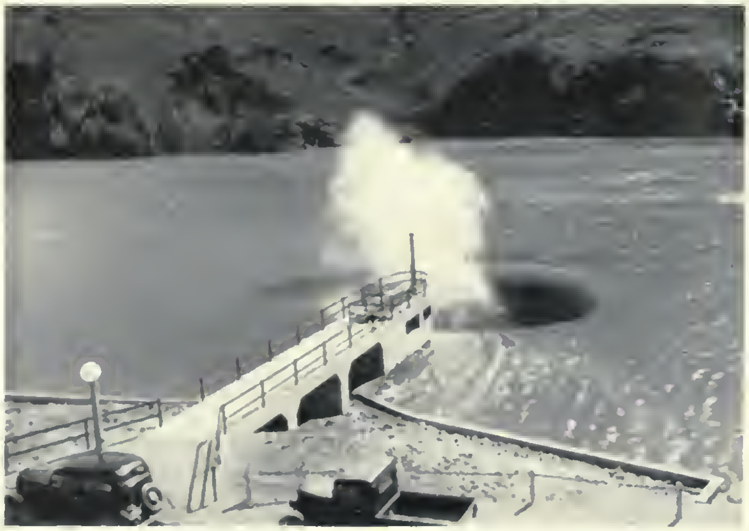


Figure 8. Spillway with $1^{1}/_{2}$-foot depth on crest.

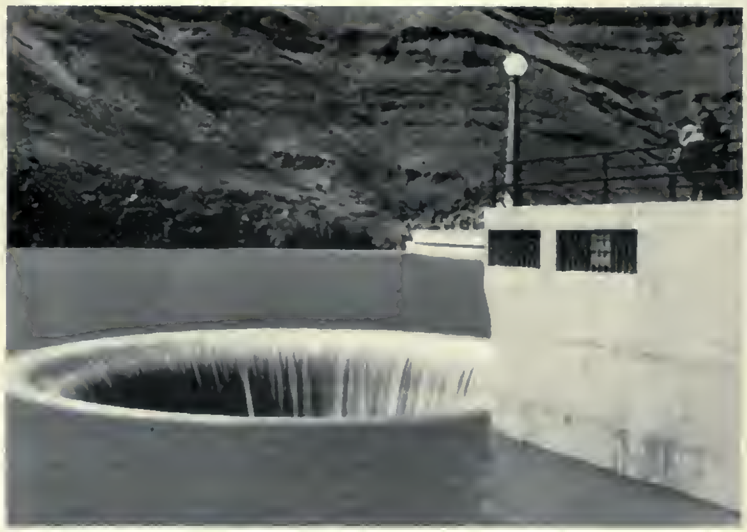


Figure 10. Spillway discharging a very thin film of water over ring gate crest. The radially converging flow is plainly seen here.

by draining water from within the hydraulic chambers faster than it flows in, causing the surface level within the chamber to lower and the gate to recede even though the reservoir continues to rise.

In the first phase, water is communicated to the chamber directly through a 24-inch inlet pipe, shown at the left of section A–A, figure 6, which extends to an inlet structure removed downstream from the crest. A valve is placed in line at the control chamber so that, if desired, the gate can be checked from rising by cutting off communication of water to the chamber.

In the control arrangement for the second phase of operation, as shown in figure 6, water is drained from the hydraulic chamber through two 24-inch, needle-type, control valves which in turn are controlled by a system of control cables and sheaves either according to the automatic action of a float located in a well above the control chamber or by a handwheel located on top of the pier. These controls are also interconnected through the various sheaves with two cables attached to the ring gate, so that a principle of counteraction is introduced whereby any movement of the gate automatically and simultaneously operates to oppose such movement, causing equilibrium of the control system to be reestablished at successive fresh positions of the gate. This principle is explained later.

The 24-inch control valves for controlling the water level in the hydraulic chamber are opened or closed by means of pilot valves connected to control cables. These cables extend upward from the valves and overwind the upper or float sheave, common to both cables, then extend downwards and across to connect with the axle of one of the twin-gate cable sheaves. The upper sheave is fastened to the lower end of a rod which extends upward through the float well and through the center of the float to the handwheel above. Clamps are attached to this rod at some preestablished point so that as the float is raised by water communicated directly from the reservoir, it contacts the clamps and exerts an upward pull on the float sheave which in turn lifts the pilot valves of the two 24-inch control valves. The same result is accomplished by turning the handwheel, serving to lift the float rod. Weights placed on the control cable where the ends connect with the pilot valves, force the control valves to seek closed positions. The weight of these must be overcome by the lift exerted on the control rods in order for the valves to open.

In providing the counteracting element of control two cables which are fastened to a bracket bolted to the bottom of the ring gate at a point near the control pier, extend upward, across pulleys, then downward to be fastened to the outer rims of the twin gate-cable sheaves.

Performance

The ring gate as designed has, except for slight modifications in the operating controls, proved entirely satisfactory mechanically; in fact, it is possible to set and hold the gate within 0.10 foot of any desired setting with the manual control. During early operation slight stiffness was encountered in the controls making it desirable to increase the weights on the pilots of the 24-inch control valves from 60 to 106 pounds each.

The automatic controls under normal conditions function as contemplated in the design; however, the gate is so responsive to fluctuations in reservoir level that, during high winds blowing downstream, the wave action causes the float to rise as much as 0.10 foot above the normal elevation, causing the gate to lower more than would be desired for the existing true reservoir level. In addition to this, a slight change in depth of water over the crest causes a considerable change in quantity of water discharged. Sudden changes in discharge make it difficult to regulate the gates on canal ditches below. In view of this, the clamp piece on the float rod was raised so that the automatic control would be inoperative through a certain range of reservoir fluctuation but would again come into play during high water so that safeguard against overtopping the dam is provided.

The Owyhee monthly report dated May 5, 1936, reads in part as follows: "The spillway ring gate was put in service for the first time on April 14, and with a few minor adjustments, was found to work perfectly. On this date (May 5, 1936) an inspection was made of the concrete at the foot of the spillway shaft, and in the diversion tunnel, and no indications of erosion were found. This was after approximately 55,000 acre-feet of water had passed over the spillway. The maximum flow over the spillway during the month is estimated to be 9,300 second-feet. The rush of water out of the spillway tunnel formed an eddy which completely cut out the small bar on which the inspector's office was located, leaving a small shelf of solid rock in front of the lower entrance to the dam, and it also washed out the railroad trestle, and about 300 feet of the fill in the canyon immediately below the dam."

During flows around 1½ feet in depth over the crest, the water falls in a solid sheet toward the center of the spillway shaft and apparently entrains air faster than it can be released at the outlet end of the spillway tunnel, causing the air pressure to build up until great enough to "regurgitate" or break through the sheet of overflowing water. This air comes through with enough force to carry spray 50 or 60 feet above the level of the gate crest, as may be seen in figure 8. This phenomenon occurs sometimes as often as once every 15 seconds and sometimes only once in 5 minutes, depending upon the tail-water elevations which are influenced, also by the water released through needle-valve outlets at the dam. For flow less than above-stated, excess entrained air is apparently able to work back unhampered. For flows greater than the 1½ feet over the crest, such as shown in figure 9, the air pressure is not sufficient to break back and is forced out through the outlet end. It is believed that a supplemental air duct could be readily provided for air escape near the bottom of the shaft which would prevent this regurgitation.

Many of the features relating to the floating-ring gate and its controlling mechanism are believed to be new and novel, and the engineers who evolved and developed these inventions have entered patent applications covering these inventions, the interests of the Government being conserved by its guaranteed right of royalty-free use of these devices covered under these patent applications, as is made mandatory by law.

Acknowledgments

This article was made possible through the cooperation of a number of Bureau of Reclamation engineers. P. A. Kinzie, senior engineer, conceived of the article originally, furnished all information on the ring-gate design, and offered constructive assistance in his review of the article. J. J. Hammond, senior engineer, furnished information on the structural design of the crest structure. Dick R. Stockham, reservoir superintendent at Owyhee, furnished information on the performance of the spillway and gate. All photographs were taken by the Bureau of Reclamation.

Irrigation History and Resettlement of Milk River Project

By GLADYS R. COSTELLO, Malta, Montana

{Continued From June Issue}

ON those high "benches" (undeveloped irrigable land) whose rich soils produced the best grass in the world, wheat farming is possible where large-scale operations can be carried out by machinery and where units of 800 to 2,000 acres can be cropped and fallowed. Possibilities of the development of flood irrigation make a few other areas suitable for farming and the raising of feed and hay crops.

But, because of the vast acreages of land fit only for livestock, it is safe to assume that stockraising will be one of the principal industries of northern Montana for some time to come. The distance from markets has always handicapped both farmers and stockmen, and home consumption of products would assist in balancing the two agricultural pursuits. If the stockman can market a share of his lamb and calf crop to the feeder in the valley and the purchaser in turn can fatten the animals on his surplus home-grown feeds, a good share of the adjustment necessary will be accomplished before a profit can be made by either the farmer or the ranchers.

In other words, assured crops raised in the irrigable valley are necessary for the economic welfare of the stockmen and the developed range lands, where they can pasture small flocks of sheep or small herds of beef cattle during the summer, are essential for the farmers whose irrigated lands are too expensive for pasture.

By the end of the fiscal year 1939 the Soil Conservation Service program of acquisition and development had resulted in the purchase of 970,199 acres of abandoned cropland. This land, overgrown with weeds and fringed sage and denuded of topsoil by wind erosion, was practically worthless as grazing land until it was reseeded, protected from trespass by range stock, and provided with sufficient stock water to make it usable in dry seasons.

Scattered over this 7,000,000-acre project area, 339 range reservoirs were created by damming coulees and providing storage for the spring run-off; 35 natural springs and old wells were cleaned out and improved; 59,704 acres of abandoned crop land were seeded to crested wheat grass; abandoned farm buildings, old sheds, corrals, and fences were removed, and dry wells and cellar holes were filled in to make the range safe for stock. Rodents were eradicated from 482,000 acres; 326 miles of line and boundary fences were constructed; nine corral and dipping-vat units were located at central locations for the use of the stockmen; and numerous other jobs such as the building of roads, cattle guards, and, in cooperation with the United States Biological Survey and the Montana fish and game department, the planting of adaptive fish and cover in some of the larger reservoirs was completed. In time, nature would have

South Wagner Community School, attended at present by 85 children.

restored the good, hardy grasses to northern Montana without another period of drought, but the reseeding of a hardy adaptive grass and the conservation of water has accomplished more in 5 years than nature could have done in 20, or perhaps would have been able to do in 120 years.

Restoration of Submarginal Range Areas

One of the big factors in restoration of the submarginal range areas has been the formation of local cooperative grazing associations, operating under the grazing service of United States Department of the Interior. Eleven such organizations control practically every acre of range land in the three counties. Range is allotted to ranchers and stockmen on a commensurate basis, no man being allowed to summer stock on the range unless he has the farm or ranch set-up to raise winter feed. These associations administer public-domain and soil-conservation lands and lease State, county, corporate, and noncorporate lands for the use of members. Such administration of the range will prevent overgrazing, neighborhood "range wars," and enable the stockmen and farmers to plan grazing programs so as to contribute to their own and the country's good. It also definitely gives preferred use of public lands to established taxpayers.

The purchase of almost a million acres of submarginal land in Phillips, Blaine, and Valley Counties displaced 901 farm families who had been clinging precariously to the borderline between making a living and being dependent upon Government loans of various kinds. Statistics on relief indicate that the majority of the displaced farmers had ceased to cling to the borderline but had definitely slipped off on the relief side.

The Farm Security Administration, whose project coincided with that of the Soil Conservation Service project, attempted to resettle as many as possible of these families on irrigable lands in the Milk River Valley. Some 18,143 acres of irrigable land had been purchased in the valley, and after subdivision into units varying in size from 80 to 160 acres, a limited number of families could be relocated.

Many of these 901 families, however, had sold their submarginal land to the Government and thus were enabled to finance their own resettlement either in other parts of the State, or in other States. Others were eligible for old-age pensions. Some found work in the towns and villages and abandoned farming as an occupation and still others drifted into the farm-labor class. During the transition period they were able to support their families by the work programs of the two Government agencies.

Subdivision of the purchased irrigable lands into 132 farm units and 31 family subsistence units was possible.

Selection of families was painstaking. Primarily a family, to come under class A requirement for resettlement, must have sold dry land or been a tenant on purchased irrigable land. Character, reputation, age, and adaptability were all taken into consideration.

Project Development

As most of the purchased irrigable land was in an undeveloped state, except for main irrigation ditches, the intensive development of this land for maximum efficiency was perhaps the most important job in connection with the resettlement of the former dry-land farmers. Approximately 814 acres out of a 15,000-acre maximum were in production in 1936, while 11,757 acres will be cropped in 1940. This figure represents the well-developed irrigable acreage and does not take into consideration the timber and pasture lands. Development of the land has consisted of leveling and draining the 11,757 acres, agricultural development of an additional 561 acres; construction of 73 miles of fence, 61 miles of irrigation ditches, 44 miles of drains, 15 miles of roads, 8 bridges, 18 river structures, and thousands of feet of irrigation culverts, and flumes, as well as the installation of such structures as turn-outs, checks, drops, and division boxes.

Modern farm homes were constructed on the South Wagner acreage and the first purchased area was approved. In addition to houses, barns, poultry houses, farmstead fences, and roads were constructed. Houses on the remaining units were lower in cost and less modern but very desirable for farm houses, being warmer, roomier and more convenient than the average farm home in this section of the country. Good farm buildings, roads, and fences were provided.

The family subsistence tracts, which vary from 1 to 5 acres, are an important part of irrigable land development on the Milk River-northern Montana project. These small tracts, upon which good houses, small barns, garages, and chicken houses have been constructed, are designed for farm laborers and heads of families who have some employment. A low rental is charged for the house and land, and much of the family living can be obtained from the small feed plot, garden, a cow, chickens, and a few pigs. Project Manager H. L. Lantz regards them as an integral part of the entire program because they serve as stepping stones up and down, to and from larger units.

Two Classes of Farm Clients

There are two classes of farm clients, lease clients, and lease and purchase clients. The former lease developed farm units from the Government on a crop share basis, paying the expenses of planting, cultivating, and harvesting, while the Government pays to the counties the equivalent of taxes as well as the irrigation charges. Lease and purchase clients are buying their developed units at the appraised possible productive value on a 40-year contract bearing 3 percent interest. The client pays 4⅓ percent of the appraised price as interest and annual payment, as well as the taxes, water charges, insurance, and upkeep. At this rate a farm valued at $7,000 will require an annual payment to the Government of about $300.

The Farm Security project office at Malta has applications on file from hundreds of dry-land farmers now living within the area who desire resettlement on irrigable farm units, but because there is no money for the purchase of irrigable land, its development, and the construction of houses and other buildings, the Farm Security Administration is without power to assist them.

On the other hand, it is estimated there are between 50,000 and 60,000 acres of undeveloped land under gravity irrigation or with less than a 20-foot lift for pumping from Milk River that could be purchased for less than $20 per acre. Recent surveys show also that approximately 300,000 acres of good lands can be developed for irrigation from the Fort Peck Reservoir. The problem is to get the lands under the control of some Federal agency where legislation would permit their development and sale to destitute families who should be devoting their time and energy toward making themselves self-supporting rather than in trying to get more relief and assistance from a benevolent government to enable them to remain on submarginal dry land in the hopes of a better crop next year.

The irrigable land in northern Montana should be purchased and developed by the Government for resettlement by worthy families now living on submarginal dry land. The development of the South Wagner community, where 24 families are now residing on land once owned by three individuals, proves conclusively that resettlement has not only benefited the farmers themselves but the community and the county. Farmers in the South Wagner community have consistently raised larger beet tonnages per acre than farmers in older communities and have made as good a showing with other crops. This in spite of the fact that a few years ago most of the land they now farm was covered with rose brush and buck brush and used only for seasonal pasture, and despite the fact that the majority of the farmers were unfamiliar with irrigation farming methods, which differ greatly from dry-land methods.

It would appear from a casual glance that purchase of approximately a million acres of submarginal dry land and the reseeding of some 60,000 acres of it to crested wheat grass would provide grazing for a lot of cows and great flocks of sheep. But this is not exactly so. In the first place, range experts agree it takes 640 acres to provide grass for 16 head of cattle or 80 head of sheep for the 8-month's grazing period. At this rate, then, additional new range has been provided for 1,500 head of cattle or 7,500 head of sheep.

Considering that there are still some 302,000 acres of submarginal land which should, according to soil conservation studies, be purchased and that there are 72,420 acres of abandoned crop land, which should be reseeded, in this acreage, it is evident that the purchase and development of submarginal land for grazing purposes is by no means completed in the Milk River-northern Montana project area.

Before the agricultural problems of the three counties which make up the Milk River-northern Montana farm security and soil conservation projects are adjusted, each farm and each community must be put to its best use.

Ranchers and farmers located on creek and river bottoms where they can raise winter feed must be assured enough summer range for an economic set-up. This range must be protected from overgrazing and trespass by such organizations as cooperative grazing associations. In the wheat farming districts, where mechanization of farming methods has been successful, the farmers must be assured sufficient acreage for economic farming. In the irrigable valleys and wherever flood irrigation is possible every acre must be put into winter feed production. In these latter valleys the farming population of the counties will be concentrated and here, by the very fact of this concentration, standards of living will rise. Better schools will be possible, electrification of farms will result, and not only the farm population but the urban population will benefit from an economically adjusted agriculture.

Family subsistence units on Milk River project farms.

Visitors to All-American Canal and Gila Projects

ON Saturday, April 20, 1940, the All-American Canal and Gila projects were visited by a group of 17 engineers and citizens representing the Water and Power Committee of the Los Angeles Chamber of Commerce. They were met and greeted at the Barbara Worth Hotel in El Centro by the construction engineer and three of his assistants and the notable visitors were then personally conducted on an all-day tour of inspection of the irrigation works in this vicinity.

Starting from the hotel, the party proceeded through the lush green fields of Imperial Valley's irrigated section, to emerge onto the virgin desert of the East Mesa. Here, ample opportunity was given the group to visualize the prodigious future this now unwatered territory will enjoy. Before continuing to Yuma, a side trip was made to the Imperial Dam and desilting works on the Colorado River northeast of Yuma. These interesting features of the twin projects were explained and inspected. Following a demonstration of gate operation at the Gila project headworks, the party adjourned to the San Carlos Hotel in Yuma, to participate in a complimentary informal luncheon arranged by Yuma's energetic Chamber of Commerce.

On the return journey to El Centro, the engineers in the party were particularly interested in the provisions being made to develop potential hydroelectric power along the route of the All-American Canal. Stops were accordingly made at three of the five drops so that this phase could be viewed at first hand. A stop at the spectacular New River siphon near Calexico completed an absorbing and informative trip for the visitors from the California city.

The members of the party as shown in the accompanying group were, left to right:

L. E. Cramer, Bureau of Reclamation, Yuma, Arizona; Gordon W. Manly, Bureau of Reclamation, Yuma; R. R. Robertson, engineer of construction, Bureau of Power and Light, City of Los Angeles; Harry Caldwell, engineer of distribution, Bureau of Power and Light, City of Los Angeles; Geo. H. Cecil, secretary, Water and Power Commission; Jack Perry, assistant to president and general manager, Pierce Bros. Funeral Directors; A. A. Anderson, chief clerk, Housing Authority, county of Los Angeles (formerly first chief engineer, Imperial Irrigation District. Made first surveys of All-American Canal in 1913–15); E. R. Northmore, president, Building and Safety

Commission, City of Los Angeles; D. H. Fry, vice president, Union Ice Co.; A. R. Arledge, assistant civil engineer and vice president, Retirement Board of Bureau of Power and Light, City of Los Angeles; N. B. Hinson, chief engineer, Southern California Edison Co.; Mrs. Hinson; Joseph Jensen, chairman, Water and Power Committee and chief petroleum engineer, Tidewater Associated Oil Co.; Mrs. W. L. Chadwick; W. L. Chadwick, civil engineer, Southern California Edison Co.; A. R. Jaquith, owner Leighton Hotel; Frank Simpson, owner Savoy Hotel, Los Angeles, and grape grower, Coachella Valley, aged 85, "youngest" member of party; Ira Dye, assistant to general sales manager, Pacific Portland Cement Co., San Francisco; L. C. Mott, secretary, Mining Committee; L. J. Foster, construction engineer, Bureau of Reclamation, Yuma; Jim A. Maltby, Bureau of Reclamation, Yuma; J. K. Rohrer, Bureau of Reclamation, Yuma.

Visitors to All-American Canal.

Great Plains Program Includes Construction of Buford-Trenton Project

CONSTRUCTION under the Great Plains Program was started May 6, 1940, by the calling of 45 WPA laborers and carpenters to the Buford-Trenton project, North Dakota, to build shops, a warehouse, and a camp. The project, located in Williams County, N. Dak., north of the Missouri River at the confluence of the Yellowstone and Missouri Rivers, is the first of a number of irrigation projects in the Great Plains dust bowl to be used for resettlement of the drouth stricken dry-land farmer.

The project is made feasible by the combination of the activities of three Government agencies. The Bureau of Reclamation, Department of the Interior, will function as the construction agency and sponsor of the project, constructing the pumping plants, dams, canal and drainage systems, and all related structures. The Farm Security Administration, Department of Agriculture, will purchase and clear and level the land, furnish clients for resettlement, and operate the project after the construction is completed. The Work Projects Administration will furnish the labor for construction under the direction of the Bureau of Reclamation engineering force. The National Resources Planning Board assisted in the planning, and the project was approved by the Northern Great Plains Committee.

There are about 21,000 acres of land under the project of which approximately 13,400 acres are classed as irrigable. To supply water to this area will require a 240 second-foot, electric-powered pumping plant with a 30-foot pumping lift, located on the Missouri River about 1½ miles west of the confluence of the Yellowstone and Missouri Rivers, 15 miles of main canal line, 20 miles of laterals, 20 miles of drains, 4 miles of power transmission supply line and various related structures. There are no difficult engineering problems expected except possibly the location of a suitable foundation for the pumping plant.

Parley Neeley (right) and James A. Callan, field engineer, discuss first day's work on project.

The total cost of the project is estimated as $1,500,000, of which $870,000 is to be allotted from WPA funds to pay for the WPA labor used on the job. The remaining $630,000 will be drawn from the $5,000,000 item under the 1939–40 Interior Department Act for Water Conservation and Utility Projects, and is the amount chargeable against the land as reimbursable construction costs.

The period required for construction is dependent upon the availability of WPA labor, but it is anticipated that water will be delivered to part of the area in the summer of 1942 and that all construction will be completed by the summer of 1943.

Employment for the project will be made through the Work Projects Administration in accordance with existing regulations. Four hundred men are to be assigned to the project. This will necessitate establishing a 100-man camp and transportation will be furnished the remaining 300 men to and from Williston, N. Dak.

Projects of the Buford-Trenton type require a large percent of skilled and intermediate classifications. Classifications such as tractor and carryall operators, dragline operators and oilers, concrete steel workers, carpenters, and other skills are made from the men assigned, providing an opportunity to learn trades they otherwise would not have.

The area in which the project is located abounds in early American exploration history. Lewis and Clark camped in 1805 at a

Upper: First men assigned to Buford-Trenton project at warehouse site near Trenton, N. Dak.

Lower: Parley R. Neeley, Resident Engineer (extreme left), instructs workers.

point now known as Fort Union, which was one of the early trading posts on the Missouri River from 1828 to 1867. The site of the old Fort Union is about a half mile west of the proposed pumping plant site for the project. Fort Buford which was established in 1867 and abandoned in 1895, is located at the mouth of the Yellowstone River and served as a trading center for the Yellowstone Valley. This fort was an important military post during the period of the Indian wars in the upper Missouri country.

Early modern American irrigation history is still represented by the pumping plant building, which is in a good state of preservation, standing as a monument and reminder of the old Buford-Trenton irrigation project, one of the first reclamation pumping projects. Its failure was mostly due to the indifference of dry-land farmers to irrigation and a succession of wet years followed completion of the irrigation works.

Projects of the Buford-Trenton type are urgently needed in the Great Plains area to stabilize the agricultural and livestock industries. They will provide permanent homes and employment for hundreds of drought victims as well as add to the national wealth.

Schedule of Irrigation Conventions

THE *National Reclamation Association* will hold its ninth annual convention in Great Falls, Mont., September 24–26. The program will include addresses by a number of nationally known men. Proceedings of the meeting will appear in the October issue of the ERA.

The *Federal Irrigation Congress* will meet at Boise, Idaho, September 16–17 and it is expected that the meeting will be attended by Bureau of Reclamation officials.

The *Oregon Reclamation Congress* is scheduled to meet in Oregon, October 28–29. Sessions are planned covering operation and maintenance, economic use of water on the farm, and permanent irrigation agriculture. A field trip is to be included.

On December 5–6 the *Washington Irrigation Institute* will hold its 1940 meeting in Pasco, Wash., the institute having accepted the joint invitation extended some time ago by the Kennewick and Pasco communities.

At the contemplated meeting, development of the Columbia Basin project and the findings and investigations at the Prosser branch irrigation experiment station, as well as the problems of soil conservation, will be given especial attention.

John S. Moore, superintendent of the Yakima project, is president of the institute.

A. S. A. E. Holds Annual Meeting

THE American Society of Agricultural Engineers held its thirty-fourth annual meeting at Pennsylvania State College June 17–20. Among other addresses delivered at the convention, the following are of special interest:

Developments in Runoff Investigations in the Northeast Region—Harold W. Hobbs, project supervisor, United States Soil Conservation Service.

Principles of Tile Drainage—J. R. Haswell, extension agricultural engineer, Pennsylvania State College.

A Graphical Method for Direct Determination of Channel Dimensions Required for Selected Velocity and Discharge Capacity, with Various Gradients and Roughness Conditions—R. B. Hickok, project supervisor, United States Soil Conservation Service.

The Cooperation of Industry and Government in the Advancement of Rural Housing and Farm Building—Dr. M. L. Wilson, director of extension, United States Department of Agriculture.

Soil and Water Conservation Problems in the Northeastern States—Dr. John P. Jones, regional conservator (Region 1), United States Soil Conservation Service.

The Relation of Raindrop Size to Erosion and Infiltration—J. Otis Laws, assistant soil conservationist, United States Soil Conservation Service.

The Place of Farm Buildings in the Land Use Program—Gladwin Young, regional representative, United States Bureau of Agricultural Economics.

A New Method for determining an Index of Supplemental Irrigation Based on Rainfall—F. E. Staebner, drainage engineer, United States Bureau of Plant Industry.

Home on a reclamation project

Arizona Desert

An irrigated farm

Farm and Home Opportunities

[See NOTE at close of listings]

Tucumcari Project, New Mexico

Description	Price and owner	Remarks
640 acres, secs. 28 and 33, T. 11 N., R. 32 E.	$9,281.60; G. W. Wells, Tucumcari, N. Mex.	Divided up in 16 40-acre tracts ranging in price from $233.50 to $2,943.80.
330.f acres, 11 miles southeast of Tucumcari, 2 miles from oiled highway. Sandy loam soil.	$3,550; ¼ down. Balance on terms at 6 percent. Mrs. C. C. Berger, 223 South 3d St., Tucumcari, N. Mex.	Divided up in 8 40-acre tracts and 1 10-acre tract. Adjacent to proposed canal line. Can give warranty deed.
300 acres, 1 mile north of Tucumcari, T. 11 N., R. 30 E. Sandy loam soil.	$9,117.40; ½ down. Balance on terms at 6 percent. Mrs. C. C. Berger, 223 South 3d St., Tucumcari, N. Mex.	Divided up in 7 40-acre tracts and 1 20-acre tract. Well adapted to diversified farming. Stone house; fenced; well.
SW¼NW¼ sec. 8, T. 11 N., R. 30 E. SE¼NW¼ sec. 8, T. 11 N., R. 30 E.	$2,500. Cash preferred, but would accept ¼ down; balance equal payments ⅓ each year at 7 percent. W. M. Coulter, Tucumcari, N. Mex.	
320 acres, 10 miles east of Tucumcari, 1½ miles from oiled highway, about ½ irrigable. T. 11 N., R. 32 E.	$8 per acre. Terms if desired. M. M. Dale, Box 1091, Borger, Tex.	Divided up in 8 40-acre tracts.

Belle Fourche Project, South Dakota

Description	Price and owner	Remarks
SE¼SE¼ sec. 21, E½NE¼ sec. 28, T. 9 N., R. 6 E., BHM. 120 acres, 100.9 acres irrigable, 1 mile from Newell, S. Dak., on a Federal highway, clay soil, topography level to steep.	$2,000; ½ down, balance on terms to be arranged. Purchaser must assume $1,000 State loan, 10 years, at 5 percent in addition to price of $2,000. J. C. Counter, 809 Bridge St., Brighton, Colo.	5-room house, cistern, stable, beet tender's house, place largely fenced with woven wire, about ½ the farm in native pasture, other half developed and producing crops.

Belle Fourche Project, South Dakota—Continued

Description	Price and owner	Remarks
N½NW¼ sec. 32, T. 8 N., R. 7 E., BHM, 80 acres, 72.8 acres irrigable, 4½ miles east of Vale, S. Dak., on main country road, sandy loam soil, level to gently sloping.	$4,000; $1,000 cash, balance 5 years at 5 percent. W. H. Thrall, 749 Wisconsin Ave., SW., Huron, S. Dak.	4-room house, barn, granary, hen house, 20 acres in alfalfa, 1 mile from beet dump, 1 mile from church, ½ mile from country school.
Lots 3 and 4, sec. 5, T. 7 N., R. 7 E., Meade County. N½SE¼ sec. 31, T. 8 N., R. 7 E., S½NW¼ sec. 32, T. 8 N., R. 7 E., BHM, Butte County. 240 acres, 203 acres irrigable, 4½ miles east of Vale, S. Dak., on main county road, sandy loam soil, level to sloping.	$10,000; ¼ cash, balance 5 annual installments at 5 percent. Union Bond and Mortgage Co., Davenport, Iowa.	7-room house, horse and cow barn, sheep shed, machine shed, 40 acres in alfalfa, 3 miles woven wire fence. Land lo sec. 5 in grass not developed for irrigation. Small area will need drainage correction. 2 80-acre tracts in good production.
E½SW¼ W½SE¼ sec. 25, T. 8 N., R. 5 E., BHM, less railroad right-of-way, total 153.59 acres, 143 acres irrigable, 2½ miles west of community of Vale, S. Dak., adjoining State graveled highway. All level land, sandy loam soil.	$3,800; ½ cash, balance on suitable terms. C. E. Mattesen, Penney Farms, Fla.	4-room house, well, cistern, granary, sheds, windbreak of native trees, sugar beet dump on the farm.
N½NE¼, SW¼NE¼, sec. 17, T. 8 N., R. 6 E., BHM, 120 acres, 50.3 acres now under irrigation, 14.6 acres suspended as class 5 land. Will need additional drainage correction. Clay soil, gently sloping. Adjoins graveled county road.	$500 cash. August Wolper, Amhurst, Colo.	7-room house, 1½ stories, stable and sheds. All buildings need reconditioning. 1 40-acre tract lies above irrigation canals and used for dry land pasture.

NOTE.—This feature was inaugurated in the March issue, and, as therein stated, *the facts presented are subject to verification, as the Bureau of Reclamation cannot undertake this task, and cannot be responsible for the accuracy of representations made.* Interested persons should communicate direct in accordance with the information given. Listings should be cleared through project offices shown on the inside of the back cover page.

Transmission Lines on the Parker Dam Power Project

By ALLEN MATTISON, *Division Engineer*

THE Parker Dam power project, now well under way by the Bureau of Reclamation, will be of benefit, directly or indirectly, to every person living on the Salt River and Gila Reclamation projects in Arizona. Therefore, progress of the development is being followed with active interest by Arizonians in all walks of life. Perhaps most keenly interested of all are the farmers, because water pumped by the electricity generated at the Parker Dam power plant will make possible the development of the Gila project and furnish additional power for pumping irrigation water on the Salt River project. In fact, the Salt River project has already begun to derive benefits from the completion of the first unit to be constructed—the Parker Dam-Phoenix transmission line which, together with the Parker Dam-Blaisdell transmission line, is the subject of this article.

About a year ago, it began to be apparent that the Salt River Valley was facing an unprecedented water shortage unless more electric power could be had for pumping. The lack of run-off to replenish the seriously depleted reservoirs of the project not only caused a water shortage for irrigation, but because a large part of the electricity for the valley is manufactured by water power, caused a power shortage as well. In effect a vicious circle—no water, no electricity—no electricity, no water.

It so happened that two of the largest customers for Parker Dam power were the Salt River Valley Water Users' Association and the Central Arizona Light and Power Co. Also, by fortunate circumstance, there was available at the Gene substation of the Metropolitan Water District of Southern California, near Parker Dam, a supply of electric power from Boulder Dam. The missing link was 140 miles of 161,000-volt transmission line between Parker Dam and Phoenix which was being designed by the Denver office of the Bureau in anticipation of the completed power house. This combination of circumstances made it advisable to rush the construction of the transmission line and complete it ahead of other units of the project in order to bring Boulder Dam power to the Salt River project under the terms of an interim contract between the United States and the Salt River Valley Water Users' Association. In fact, location of the transmission line was begun early in 1939 by survey parties from the Salt River project even before the creation of the Parker Dam power project.

The transmission line is commonly known as wood pole H-frame construction. That is, each structure consists of two western red

The Blaisdell line crossing the Colorado.

cedar poles set 17 feet apart and supporting a cross arm 34 feet 8 inches long from which is suspended the copper conductors. Although the poles vary from 45 to 75 feet in length, the majority of them are 60 feet long and are set 8 feet in the ground. The average span is 635 feet and the longest span 1,900 feet. The cross arms consist of two 4-inch by 12-foot surfaced Douglas Fir planks bolted together, one on each side of the poles. From these cross arms the conductor is suspended by strings of disk insulators with 11 units per string.

Nearly 4 million pounds of copper went into the manufacture of conductor for the 2 lines and it weighs approximately 1 pound per foot. In order to reduce line losses and permit more efficient operation, the conductors are hollow. The construction is accomplished by wrapping 12 strands of wire around a small twisted I-beam of copper. The finished product is three-fourths of an inch in diameter. Hollow conductor of this and similar types is becoming quite common for use on transmission lines of high voltage and large capacity.

Parker Dam-Phoenix Line

The line from Parker Dam to Phoenix will deliver 80,000 horsepower at 161,000 volts. It is being operated in the present emergency at 69,000 volts and the capacity is about 20,000 horsepower at that voltage. Transformers for the designed voltage will not be installed until the Parker Dam power plant is ready for operation. However, 20,000 horsepower during the next 2 years will be a welcome relief for the already overloaded generating plants of the Salt River Valley.

The Phoenix line traverses a part of Arizona where lightning storms, at times, are very severe and where the dry desert soil offers a very high resistance to dissipation of lightning strokes. Because of the importance of this line it was believed desirable to have maximum protection from interruptions to service from this cause. To provide lightning protection there are two overhead ground wires of ⅜-inch high-strength steel the entire length of the line strung from pole top to pole top and attached to a wire which runs down each pole into the ground. These in turn are attached to two ¼-inch copper wires buried underground parallel to the transmission line. A complete series of tests shows that this construction provides sufficient "ground capacity" to dissipate severe lightning strokes without serious interruptions to service.

As a further aid to efficient operation a disconnect switch has been installed approximately in the middle of each line. In case of trouble on the line the switch can be opened and tests made to determine on which half of the line the outage has occurred and thereby reduce the time necessary for locating and reporting the break. A telephone line to be constructed during 1940 will be a further aid in patrolling as well as load dispatching.

The Phoenix line north from Cunningham Pass, Harcuvar Mountains.

Stringing the wires; crossarms, insulators, conductor, ground wires, etc., were placed in one operation, pole heights 50 to 65 feet.

Parker Dam-Blaisdell Line

The Blaisdell line from Parker Dam to pumping plant No. 1 of the Gila project, near Yuma, is the same design as the Phoenix line with the exception of overhead and underground ground wires. However, the ground wires on each pole were installed which will make it easy to construct a complete grounding system at some future time if it is found advisable. Although built under a schedule of the present contract, the Blaisdell line will not be used until completion of the Parker power plant and the Gila pumping plant.

One of the most interesting features of the job was the amount and variety of equipment used by Dwight Chapin, Jr., the contractor. Primarily, construction of transmission lines is a hauling job. This was especially true of the Parker Dam to Phoenix and Blaisdell lines because of the few points of contact with railroads. Long hauls for men, materials, and equipment were the order rather than the exception and required 30 to 40 trucks and tractors. Poles, conductor, and other materials were delivered to the site of the work with very little confusion and error which speaks well for the efficiency of the contractor's organization.

Hole digging was done with power machinery wherever possible. A 28-inch earth boring bit was mounted on a 1½-ton truck equipped with power drive to utilize the truck motor. A power winch and derrick frame mounted on the same truck raised

Placing the poles.

the pole as soon as the hole was completed.

Wire was strung from moving reels. Each reel was mounted on a specially constructed two-wheeled trailer and hauled along the line with a tractor paying out the conductor behind. For most of the distance the center wire was strung from a reel mounted on a four-wheel-drive truck on which was also mounted the two reels of overhead ground wire and a high derrick for raising the cross arms. The operation of this particular piece of equipment was one of the most interesting on the job.

The conductors were placed in the blocks and the entire assembly raised above the poles and lowered into place. As many as 5 miles of line were erected in one day. On the Blaisdell line where there were no overhead ground wires the record day was 7 miles of conductor.

A smaller wire-sagging crew followed behind the stringing and operated generally as an independent unit. After some experimenting, it was found that approximately 2 miles of line made the most economical length to sag. As many as three sags were made on 1 day when no difficulties were encountered.

The underground ground wires or counterpoise, as it is called, was plowed in to a depth of 2 feet with a heavy duty subsoiler on which the blade had been reinforced. The reel of counterpoise wire was mounted on a trailer and attached ahead of the subsoiler. This outfit was hauled by a 75-horsepower diesel tractor.

The Phoenix line was completed and tested on the last day of January 1940 and delivery of electricity to the Salt River Valley was begun immediately. The Blaisdell line was completed about the middle of March but will not be placed in service until the completion of the Gila pumping plant and the Parker power plant.

NOTES FOR CONTRACTORS

Specification No.	Project	Bids opened	Work or material	Low bidder		Bid	Terms	Contract awarded
				Name	Address			
900	Boulder Canyon, Ariz.-Nev.	Apr. 29	Power transformers and current limiting reactor for unit A-9, Boulder power plant.	Moloney Electric Co.	St. Louis, Mo.	[1] $91,600	F. o. b. Boulder City, Nev.	June 28
				Railway & Industrial Engineering Co.	Greensburg, Pa.	[2] 47,825	do	Do.
910	Columbia Basin, Wash.	June 14	Disconnecting switches and lightning arresters for the Grand Coulee power plant.	Bowie Switch Co.	San Francisco, Calif.	[3] 21,550	F. o. b. Odair, Wash.	June 27
				Westinghouse Electric & Manufacturing Co.	Denver, Colo.	[4] 19,890	F. o. b. Odair, Wash., shipping point E. Pittsburgh.	Do.
1362-D	Central Valley, Calif.	May 16	Pier plates and pier-plate erection trusses for drum gates at Friant Dam.	The Stearns-Roger Manufacturing Co.	do	[1] 12,365	F. o. b. Denver.	June 21
				International Derrick and Equipment Co. of Calif.	Torrance, Calif.	[2] 1,473	F. o. b. Torrance, discount ½ percent.	May 27
1370-D	Columbia Basin, Wash.	June 18	11 24-inch internal differential regulating valves for Grand Coulee Dam.	Commercial Iron Works	Portland, Oreg.	11,794	F. o. b. Portland, Oreg.	June 26
1371-D	Central Valley, Calif.	June 17	4 discharge cones for temporary discharge nozzles on 110-inch diameter outlet pipes at Friant Dam.	Southwest Welding & Manufacturing Co.	Alhambra, Calif.	4,868	F. o. b. Alhambra, discount ½ percent.	June 21
1372-D	Colorado River, Tex.	June 19	Air-inlet piping for 102-inch gates for outlet works at Marshall Ford Dam.	Crane-O'Fallon Co.	Denver, Colo.	27,000	F. o. b. Chicago, discount 2 percent.	July 1
36,524-A	Altus, Okla.	May 7	1 1½ cubic yard dragline excavator.	Northwest Engineering Co.	Chicago, Ill.	15,840	F. o. b. Green Bay, Wis.	June 20
B-38,318-B	Columbia Basin, Wash.	June 14	Steel reinforcement bars (1,980,000 pounds).	Bethlehem Steel Co.	San Francisco, Calif.	44,454	F. o. b. Odair, discount ½ percent on $0.47 less than bid prices.	June 26
E-23,001-A	Boulder Canyon, Ariz.-Nev.	June 4	5,000 barrels of oil-well cement in paper sacks.	California Portland Cement Co.	Los Angeles, Calif.	11,800	F. o. b. Colton, Calif.	June 21
909	Colorado River, Tex.	June 14	Completion of construction of Marshall Ford Dam.	Cage Bros. & W. W. Vann & Co.	Bishop, Tex.	[4] 903,102		July 2
911	Gila, Ariz.	June 13	Pumping plant No. 1, Gravity Main Canal.	Charles J. Dorfman	Los Angeles, Calif.	265,743		July 8
1369-D	Yakima-Roza, Wash.	June 17	Radial gates and radial-gate hoists for Yakima Ridge Canal and Wasteway No. 2.	Valley Iron Works	Yakima, Wash.	[1] 1,753	F. o. b. Terrace Heights and Zillah, discount 5 percent.	July 2
						[2] 830	do	Do.
						[5] 5,395	do	Do.
52	Parker Dam Power, Calif.-Ariz.	June 27	Hauling concrete aggregates	Cozens and Hammond	Encinitas, Calif.	27,500.00		July 12
1376-D	Kendrick, Wyo.	July 1	Transformers, oil circuit breakers, lightning arresters and disconnecting switches for Thermopolis and Casper substations, and Casper-Thermopolis transmission line.	Westinghouse Electric & Manufacturing Corporation.	Denver, Colo.	[3] 21,140.00		July 15
				Allis-Chalmers Manufacturing Co.	Milwaukee, Wis.	[4] 2,490.00		July 12
				Pacific Electric Manufacturing Corporation.	San Francisco, Calif.	[6] 12,351.00		July 15
				Electric Power Equipment Corporation.	Philadelphia, Pa.	[7] 3,291.00		July 16
				Westinghouse Electric & Manufacturing Corporation.	Denver, Colo.	[8] 1,000.92		July 15
912	Colorado-Big Thompson, Colo.	June 20	Continental Divide Tunnel, stations 6 to 72.	Platt Rogers Inc	Pueblo, Colo.	389,370.00	Completion 370 days	July 13
914	Columbia Basin, Wash.	July 1	Superstructure for Kettle Falls bridge on Great Northern R. R. relocation.	American Bridge Co.	Pittsburgh, Pa.	499,319.00	Completion 260 days	July 16
915	do	June 26	Earthwork, structures and track for Great Northern R. R. relocation, Kettle Falls to Williams and Kettle Falls to Boyds; and adjacent highway relocation.	J. A. Terteling & Sons	Boise, Idaho	[3] 643,461.60	Completion 275 days	July 15
						[4] 398,875.25		Do.
33,493-A	Central Valley, Calif.	June 24	2 75 horsepower Diesel-engine-powered crawler tractors.	Caterpillar Tractor Co.	Peoria, Ill.	13,764.60	Discount $100	July 23
1377-D	Ogden River, Utah	June 13	Steel pipe and fittings	Southern Pipe & Casing Co.	Azusa, Calif.	36,290.17	F. o. b. Ogden	July 24
1373-D	Columbia Basin, Wash.	June 26	Aluminum windows, louvers and doors and glass block framing members.	Artistic Iron Products Co.	Cleveland, Ohio	[9] 27,910.00	Discount 2 percent	Do.
B-42,483-A	All-American Canal, Ariz.-Calif.	July 8	4 Automobile dump trucks	Yellow Truck & Coach Manufacturing Co.	Pontiac, Mich.	11,546.04	Discount 5 percent	Do.
1374-D	Yakima-Roza, Wash.	June 25	Structural steel for Northern Pacific R. R. bridge, for 2 highway bridges and for a metal flume over Wasteway No. 2.	American Bridge Co.	Denver, Colo.	[3] 3,417.00	F. o. b. Gary, Ind.	July 22
				Milwaukee Bridge Co.	Milwaukee, Wis.	[4] 2,448.00	Discount ½ percent	July 23

[1] Item 1.
[2] Item 2.
[3] Schedule 1.
[4] Schedule 2.
[5] Items 3 and 4.
[6] Schedule 3.
[7] Schedule 4.
[8] Schedule 5.
[9] Items 1 and 2.

Origin of Names of Projects and Project Features in Reclamation Territory

Minidoka Project, Idaho[1]

Minidoka.—This name which has been applied to the project proper, the diversion dam at the head of the project, and the county in which is located the Gravity division, is a Shoshone Indian word meaning broad expanse.

Accquia.—A town in Minidoka County with a Spanish name meaning canal or water course.

American Falls.—A town, reservoir, and natural falls in Snake River named for a party of trappers of the American Fur Co., the members of which were carried over the falls in canoes.

Burley.—The largest town on the project and county seat of Cassia County, named for D. E. Burley, then general passenger agent of the Oregon Short Line (Union Pacific) Railroad.

Cassia.—The county lying south of Snake River in which the South Side Pumping division and part of the Gravity division are situated. So named for the Cassia plant which grows along the creek bottoms.

Declo.—A town in Cassia County named for two pioneer families—Dethles and Cloughly.

Heyburn.—A town in Minidoka County named for former United States Senator W. B. Heyburn of Idaho.

Jackson Lake.—A reservoir in Wyoming named for William Jackson, the discoverer of the original lake, and a famous explorer.

Paul.—A town in Minidoka County named for C. H. Paul, then project manager of the project and now consulting engineer.

Rupert.—A town, county seat of Minidoka County, said to have been named for Rupert Hughes, the writer, and also to have been named by its citizens.

Walcott Lake.—The reservoir created by Minidoka Dam whence water is diverted into project canals, and a source of power at the Minidoka power plant, was named for Charles D. Walcott, Director of the United States Geological Survey when the original reclamation act was passed.

Yuma Project, Arizona

Yuma.—Historical accounts of our great Southwest contain an interesting explanation concerning the origin of the name Yuma. Early Spanish explorers and adventurers who crossed the Colorado just below its junction with the Gila, noted the more or less permanent camps of Indians inhabiting this part of the country. Thereafter travelers, suffering the hardships usually incident to crossing this desert country, would, as soon as the valley of the Colorado was reached, look searchingly for signs of Indian campfire smoke rising skyward. Here they knew were unfailing supplies of fresh water and a place to cross over the river which marked an important mile post in their journey. The Spanish word for smoke, "humo," was applied to this crossing place. Soon the name was corrupted to "huma" and finally to Yuma. Oddly enough the town which grew up here was later called Arizona City, but by an act of the Territorial Legislature this name in 1873 was changed to Yuma. The name Yuma generally applied to the Indians who live here is a misnomer for they really belong to the Quechan tribe.

This is No. 4 in the series of articles on this subject, and includes the Minidoka, Yuma, Parker Dam, and Upper Snake River projects.

When the Bureau of Reclamation conceived and built the irrigation project in this vicinity about 30 years ago, it was only natural that it should be named for the city of Yuma, then the only town of any importance within its area.

Gadsden.—The name of this town was given in honor of James Gadsden, United States Minister to Mexico in President Pierce's administration and author of the Gadsden Purchase.

Somerton.—This name came from the birthplace in Ohio of the town's principal founder.

Laguna.—The name given to the diversion dam across the Colorado is the Spanish word for "lake."

Canals in the reservation division of the project situated on the California side of the Colorado were named for various Indian tribes such as the Mojave, Cocopah, Pima, Hopi, etc.

Canals in the Valley division of the project on the Arizona side of the river were named individually in most instances for that settler who first used the newly constructed canal to irrigate the virgin soil of his improved homestead—a fitting way to perpetuate the names of those courageous pioneers who led the way, with great sacrifice and hardships, in transforming the desert into productive farm lands.

Parker Dam Project, California

Parker Dam.—The dam was named after the town of Parker, Ariz., a small town located 16 miles downstream on the Arizona side of the Colorado River, which took its name in 1905 from Frank Parker, civil engineer, surveying for the Arizona & California Railroad Co. Parker, Ariz., has an interesting background in that it is located near the center of the Colorado River Indian Reservation where a number of tribes of Indians have lived perhaps for centuries and where in 1867 was written the first chapter in the history of an irrigation project undertaken by the United States Government, for on March 2, 1867, Congress appropriated $50,000 for the construction of an irrigation system from the Colorado River over the bottom lands of this reservation.

George W. Dent, a relative of President Grant, was appointed Superintendent of Indian Affairs, and on December 16, 1867, he employed native Indians with picks and shovels and started the task of building a main canal approximately 12 miles long. A natural headgate was made by tunneling through a large out-cropping of rock which is now referred to as Headgate Rock.

This work was accomplished with but very little aid of horsepower, slips, or graders, and on June 16, 1874, the first Colorado River water was delivered for irrigation purposes on a Government project.

Between 1867 and 1882 mail and supplies were delivered from Yuma 140 miles downstream by steamboat, on which wood was burned for fuel. Between 1882 and 1894 mail and supplies arrived by boat and stagecoach from Needles, Calif., 65 miles distance.

Bill Williams River.—This river is believed to have been named after a pioneer settler in the early eighties, although this is by no means authenticated. The river flows into Lake Havasu.

Colorado River Aqueduct.—The Colorado River Aqueduct was so named by a board of directors of the Metropolitan Water District of Southern California in 1928. This aqueduct consists of a main conduit 242 miles long, extending from the banks of Lake Havasu at a point 2 miles upstream from Parker Dam,

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[1] Most of the information on the origin of Minidoka project names was obtained from a recently published book Idaho—A Guide in Word and Picture, prepared by Federal Writers Projects of W. P. A., although some data came from other sources.

Mohave Indians overlooking lake created by Parker Dam.

to Cajalco Reservoir near Riverside, Calif., and a distribution system leading to various consumption centers, which is referred to as the Metropolitan area, or the "Thirteen Golden Cities."

Lake Havasu.—The 50-mile-long body of water created by Parker Dam on the Colorado River was officially named by the Bureau of Reclamation and approved by the United States Board of Geographic Names on May 26, 1939. The name "Havasu," meaning "lake of the blue waters," was first given the lake on January 5, 1939, by a 102-year-old Mojave Indian, Haranai, and his 97-year-old wife, Ooach, whose interest was quickly captured when they first saw the new artificial man-made lake with its clear blue, sparkling waters.

Upper Snake River Project, Idaho[2]

Island Park.—The name was given this section of country because in the midst of a great area, thickly wooded, this portion was without timber—an area of open country completely surrounded by timber.

Grassy Lake.—A very coarse, rank grass grows in the lake, all over the bed of the lake and extending above the water level—a rather unusual thing.

Cross Cut Canal.—Crosses from one stream to another—a cutting across.

St. Anthony.—Named for or after the St. Anthony Falls of the Mississippi, near St. Paul and Minneapolis.

Rexburg.—The founder of this town was Thomas E. Ricks. We have been told that he was of German extraction and the family name of Ricks is a derivative of Rex (king)—Rexburg—King or Chief City. However, Defenbach's history of Idaho states that the town was originally named Ricksburg, and that gradually through usage the name evolved into Rexburg.

Fremont County.—Named for John C. Fremont, the pathfinder. Strange as it may be, Captain Fremont never set foot in any part of Fremont County.

Cascade Creek.—After flowing through a grassy dell, the last approximately 80 rods of its course in reaching Fall River (Falling Fork) is by a series of falls or cascades.

North Fork, Snake River.—This is a recent designation—the correct name is Henry's Fork, after its discoverer, Capt. Andrew Henry, who erected a post on its south or left bank, near St. Anthony in 1811. Incidentally this post was the second white man's habitation in Idaho, and the first American-owned trading post west of the Rocky Mountains.

New Power Transmission Map No longer available

THE new map of the Main Power Transmission Lines in Western United States numbered 40-7 (1940), which was recently placed on sale by the Bureau of Reclamation at a price of 25 cents each, as announced in the July number of the ERA, is no longer available for general distribution.

Upstream face of Island Park Dam, Upper Snake River project.

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[2] One of the older project settlers has furnished a list of project names and their origin as here given.

HOLIDAY TIME AT LAKE MEAD

Parades, fishing, boating on blue water through painted scenery—visitors galore characterize America's vacation months at Lake Mead, the spectacular playground created by Boulder Dam.

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Projects under construction or operated in whole or in part by the Bureau of Reclamation

Project	Office	Official in charge		Chief clerk	District counsel	
		Name	Title		Name	Address
All-American Canal	Yuma, Ariz	Leo J. Foster	Construction engineer	J. C. Thrailkill	R. J. Coffey	Los Angeles, Calif.
Altus	Altus, Okla	Russell S. Lieurance	Construction engineer	Edgar A. Peek	H. J. S. Devries	El Paso, Tex.
Belle Fourche	Newell, S. Dak	F. C. Younghlutt	Superintendent		W. J. Burke	Billings, Mont.
Boise	Boise, Idaho	R. J. Newell	Construction engineer	Robert B. Smith	B. E. Stoutemyer	Portland, Oreg.
Boulder Canyon [1]	Boulder City, Nev	Irving C. Harris	Director of power	Gail H. Baird	R. J. Coffey	Los Angeles, Calif.
Buffalo Rapids	Glendive, Mont	Paul A. Jones	Construction engineer	Edwin M. Bean	W. J. Burke	Billings, Mont.
Buford-Trenton	Williston, N. Dak	Parley R. Neeley	Resident engineer	Robert L. Newman	W. J. Burke	Billings, Mont
Carlsbad	Carlsbad, N. Mex	L. E. Foster	Superintendent	E. W. Shepard	H. J. S. Devries	El Paso, Tex.
Central Valley	Sacramento, Calif	W. R. Young	Supervising engineer	E. R. Mills	R. J. Coffey	Los Angeles, Calif.
Shasta Dam	Redding, Calif	Ralph Lowry	Construction engineer		R. J. Coffey	Los Angeles, Calif.
Friant division	Friant, Calif	R. B. Williams	Construction engineer		R. J. Coffey	Los Angeles, Calif.
Delta division	Antioch, Calif	Oscar G. Boden	Construction engineer		R. J. Coffey	Los Angeles, Calif.
Colorado-Big Thompson	Estes Park, Colo	Porter J. Preston	Supervising engineer	C. M. Voyen	J. R. Alexander	Salt Lake City, Utah.
Colorado River	Austin Tex	Ernest A. Moritz	Construction engineer	William F. Sha	H. J. S. Devries	El Paso, Tex.
Columbia Basin	Coulee Dam, Wash	F. A. Banks	Supervising engineer	C. B. Funk	B. E. stoutemyer	Portland, Oreg.
Deschutes	Bend, Oreg	D. S. Stuver	Construction engineer	Nohle O. Anderson	B. E. Stoutemyer	Portland, Oreg.
Gila	Yuma, Ariz	Leo J. Foster	Construction engineer	J. C. Thrailkill	R. J. Coffey	Los Angeles, Calif.
Grand Valley	Grand Junction, Colo	W. J. Chiesman	Superintendent	Emil T. Ficenec	J. R. Alexander	Salt Lake City, Utah.
Humboldt	Reno, Nev	Floyd M. Spencer	Construction engineer [2]		J. R. Alexander	Salt Lake City, Utah.
Kendrick	Casper, Wyo	Irvin J. Matthews	Construction engineer [2]	George W. Lyle	W. J. Burke	Billings, Mont.
Klamath	Klamath Falls, Oreg	B. E. Hayden	Superintendent	W. I. Tingley	B. E. Stoutemyer	Portland, Oreg.
Milk River	Malta, Mont	Harold W. Cenger	Superintendent	E. E. Chabot	W. J. Burke	Billings, Mont.
Minidoka	Burley, Idaho	Stanley R. Marean	Superintendent	G. C. Patterson	B. E. Stoutemyer	Portland, Oreg.
Minidoka Power Plant	Rupert, Idaho	S. A. McWilliams	Resident engineer		B. E. Stoutemyer	Portland, Oreg.
Mirage Flats	Hemingford, Nebr	Denton J. Paul	Construction engineer		W. J. Burke	Billings, Mont.
Moon Lake	Provo, Utah	E. O. Larson	Construction engineer	Francis J. Farrell	J. R. Alexander	Salt Lake City, Utah.
North Platte	Guernsey, Wyo	C. F. Gleason	Superintendent of power	A. T. Stimpfig	W. J. Burke	Billings, Mont.
Ogden River	Provo, Utah	E. O. Larson	Construction engineer	Francis J. Farrell	J. R. Alexander	Salt Lake City, Utah.
Orland	Orland, Calif	D. L. Carmody	Superintendent	W. D. Funk	R. J. Coffey	Los Angeles, Calif.
Owyhee	Boise, Idaho	R. J. Newell	Construction engineer	Robert B. Smith	B. E. Stoutemyer	Portland, Oreg.
Parker Dam Power	Parker Dam, Calif	E. C. Koppen	Construction engineer	George B. Snow	R. J. Coffey	Los Angeles, Calif.
Pine River	Vallecito, Colo	Charles A. Burns	Construction engineer	Frank E. Gawn	J. R. Alexander	Salt Lake City, Utah.
Rapid Valley	Rapid City, S. D	Horace V. Hubbell	Construction engineer	Jos. P. Siebeneicher	W. J. Burke	Billings, Mont.
Provo River	Provo, Utah	E. O. Larson	Construction engineer	Francis J. Farrell	J. R. Alexander	Salt Lake City, Utah.
Rio Grande	El Paso, Tex	L. R. Fiock	Superintendent	H. H. Berryhill	H. J. S. Devries	El Paso, Tex.
Elephant Butte Power Plant	Elephant Butte, N. Mex	C. O. Dale	Acting resident engineer	H. H. Berryhill	H. J. S. Devries	El Paso, Tex.
Riverton	Riverton, Wyo	H. D. Comstock	Superintendent	C. B. Wentzel	W. J. Burke	Billings, Mont.
Shoshone	Powell, Wyo	L. J. Windle	Superintendent [2]	L. J. Windle [2]	W. J. Burke	Billings, Mont.
Heart Mountain division	Cody, Wyo	Walter F. Kemp	Construction engineer	L. J. Windle [2]	W. J. Burke	Billings, Mont.
Sun River	Fairfield, Mont	A. W. Walker	Superintendent		W. J. Burke	Billings, Mont.
Truckee River Storage	Reno, Nev	Floyd M. Spencer	Construction engineer [2]		J. R. Alexander	Salt Lake City, Utah.
Tucumcari	Tucumcari, N. Mex	Harold W. Mutch	Resident Engineer	Charles L. Harris	H. J. S. Devries	El Paso, Tex.
Umatilla (McKay Dam)	Pendleton, Oreg	G. L. Tice	Reservoir superintendent		B. E. Stoutemyer	Portland, Oreg.
Uncompahgre: Repairs to canals	Montrose, Colo	Hermon R. Elliott	Construction engineer [2]	Ewalt P. Anderson	J. R. Alexander	Salt Lake City, Utah.
Upper Snake River Storage [3]	Ashton, Idaho	I. Donald Jerman	Construction engineer [2]	Emmanuel V. Hillius	B. E. Stoutemyer	Portland, Oreg.
Vale	Vale, Oreg	C. C. Ketchum	Superintendent		B. E. Stoutemyer	Portland, Oreg.
Yakima	Yakima, Wash	J. S. Moore	Superintendent	Conrad J. Ralston	B. E. Stoutemyer	Portland, Oreg.
Roza division	Yakima, Wash	Charles E. Crownover	Construction engineer	Alex S. Harker	B. E. Stoutemyer	Portland, Oreg.
Yuma	Yuma, Ariz	C. B. Elliott	Superintendent	Jacob T. Davenport	R. J. Coffey	Los Angeles, Calif.

[1] Boulder Dam and Power Plant.

[2] Acting.

[3] Island Park and Grassy Lake Dams.

Projects or divisions of projects of Bureau of Reclamation operated by water users

Project	Organization	Office	Operating official		Secretary	
			Name	Title	Name	Address
Baker	Lower Powder River irrigation district	Baker, Oreg	A. Oliver	President	Marion Hewlett	Keating.
Bittor Root [4]	Bitter Root irrigation district	Hamilton, Mont	G. R. Walsh	Manager	Elsie W. Oliva	Hamilton.
Boise [1]	Board of Control	Boise, Idaho	Wm. H. Tuller	Project manager	L. P. Jensen	Boise.
Boise [1]	Black Canyon irrigation district	Notus, Idaho	Chas. W. Holmes	Superintendent	L. M. Watson	Notus.
Burnt River	Burnt River irrigation district	Huntington, Oreg	Edward Sullivan	President	Harold H. Hursh	Huntington.
Frenchtown	Frenchtown irrigation district	Frenchtown, Mont	Tom Sheffer	Superintendent	Ralph P. Scheffer	Huson.
Fruitgrowers Dam	Orchard City irrigation district	Austin, Colo	S. F. Newman	Superintendent	A. W. Lanning	Austin.
Grand Valley, Orchard Mesa [3]	Orchard Mesa irrigation district	Grand Junction, Colo	Jack H. Naeve	Superintendent	C. J. McCormick	Grand Jctn.
Humboldt	Pershing County water conservation district	Lovelock, Nev	Roy F. Meffley	Superintendent	G. H. Jones	Lovelock.
Huntley [4]	Huntley Project irrigation district	Ballantine, Mont	E. E. Lewis	Manager	H. S. Elliott	Ballantine.
Hyrum [3]	South Cache W. U. A	Logan, Utah	H. Smith Richards	Superintendent	Harry C. Parker	Logan.
Klamath, Langell Valley [1]	Langell Valley irrigation district	Bonanza, Oreg	Chas. A. Revell	Manager	Chas. A. Revell	Bonanza.
Klamath, Horsefly [1]	Horsefly irrigation district	Bonanza, Oreg	Benson Dixon	President	Dorothy Eyers	Bonanza.
Lower Yellowstone [4]	Board of Control	Sidney, Mont	Axel Persson	Manager	Axel Persson	Sidney.
Milk River: Chinook division [4]	Alfalfa Valley irrigation district	Chinook, Mont	A. L. Benton	President	R. H. Clarkson	Chinook.
	Fort Belknap irrigation district	Chinook, Mont	H. B. Bonebright	President	L. V. Bogy	Chinook.
	Zurich irrigation district	Chinook, Mont	C. A. Watkins	President	H. M. Montgomery	Chinook.
	Harlem irrigation district	Harlem, Mont	Thos. M. Everett	President	R. L. Barton	Harlem.
	Paradise Valley irrigation district	Zurich, Mont	C. J. Wurth	President	J. F. Sharples	Zurich.
Minidoka: Gravity [1]	Minidoka irrigation district	Rupert, Idaho	Frank A. Ballard	Manager	O. W. Paul	Rupert.
Pumping	Burley irrigation district	Burley, Idaho	Hugh L. Crawford	Manager	Frank O. Redfield	Burley.
Gooding [1]	Amer. Falls Reserv. Dist. No. 2	Gooding, Idaho	S. T. Baer	Manager	Ida M. Johnson	Gooding.
Moon Lake	Moon Lake W. U. A	Roosevelt, Utah	H. J. Allred	President	Louie Galloway	Roosevelt.
Newlands [3]	Truckee-Carson irrigation district	Fallon, Nev	W. H. Wallace	Manager	H. W. Emery	Fallon.
North Platte: Interstate division [4]	Pathfinder irrigation district	Mitchell, Nebr	T. W. Parry	Manager	Flora K. Schroeder	Mitchell.
Fort Laramie division [4]	Gering-Fort Laramie irrigation district	Gering, Nebr	W. O. Fleenor	Superintendent	C. G. Klingman	Gering.
Fort Laramie division [4]	Goshen irrigation district	Torrington, Wyo	Floyd M. Roush	Superintendent	Mary E. Harrach	Torrington.
Northport division [4]	Northport irrigation district	Northport, Nebr	Mark Iddings	Manager	Mabel J. Thompson	Bridgeport.
Ogden River	Ogden River W. U. A	Ogden, Utah	David A. Scott	Superintendent	Wm. P. Stephens	Ogden.
Okanogan [1]	Okanogan irrigation district	Okanogan, Wash	Nelson D. Thorp	Manager	Nelson D. Thorp	Okanogan.
Salt River [2]	Salt River Valley W. U. A	Phoenix, Ariz	H. J. Lawson	Superintendent	F. G. Henshaw	Phoenix.
Sanpete: Ephraim division	Ephraim Irrigation Co	Ephraim, Utah	Andrew Hansen	President	John K. Olsen	Ephraim.
Spring City division	Horseshoe Irrigation Co	Spring City, Utah	Vivian Larson	President	James W. Blain	Spring City.
Shoshone: Garland division [4]	Shoshone irrigation district	Powell, Wyo	Paul Nelson	Irrigation superintendent	Harry Barrows	Powell.
Frannie division [4]	Deaver irrigation district	Deaver, Wyo	Floyd Lucas	Manager	R. J. Schwendiman	Deaver.
Stanfield	Stanfield irrigation district	Stanfield, Oreg	Leo F. Clark	Superintendent	F. A. Baker	Stanfield.
Strawberry Valley	Strawberry Water Users' Assn	Payson, Utah	S. W. Grotegut	President	E. G. Breeze	Payson.
Sun River: Fort Shaw division [4]	Fort Shaw irrigation district	Fort Shaw, Mont	C. L. Bailey	Manager	C. L. Bailey	Fort Shaw.
Greenfields division	Greenfields irrigation district	Fairfield, Mont	A. W. Walker	Manager	H. P. Wangen	Fairfield.
Umatilla, East division [1]	Hermiston irrigation district	Hermiston, Oreg	E. D. Martin	Manager	Enos D. Martin	Hermiston.
West division [1]	West Extension irrigation district	Irrigon, Oreg	A. C. Houghton	Manager	A. C. Houghton	Irrigon.
Uncompahgre [3]	Uncompahgre Valley W. U. A	Montrose, Colo	Jesse R. Thompson	Manager	H. D. Galloway	Montrose.
Upper Snake River Storage	Fremont-Madison irrigation district	St. Anthony, Idaho	H. G. Fuller	President	John T. White	St. Anthony.
Weber River	Weber River W. U. A	Ogden, Utah	D. D. Harris	Manager	D. D. Harris	Ogden.
Yakima, Kittitas division [1]	Kittitas reclamation district	Ellensburg, Wash	G. G. Hughes	Manager	G. L. Sterling	Ellensburg.

[1] B. E. Stoutemyer, district counsel, Portland, Oreg.
[2] R. J. Coffey, district counsel, Los Angeles, Calif.
[3] J. R. Alexander, district counsel, Salt Lake City, Utah.
[4] W. J. Burke, district counsel, Billings, Mont.

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SALLIE A. B. COE, *Editor*.

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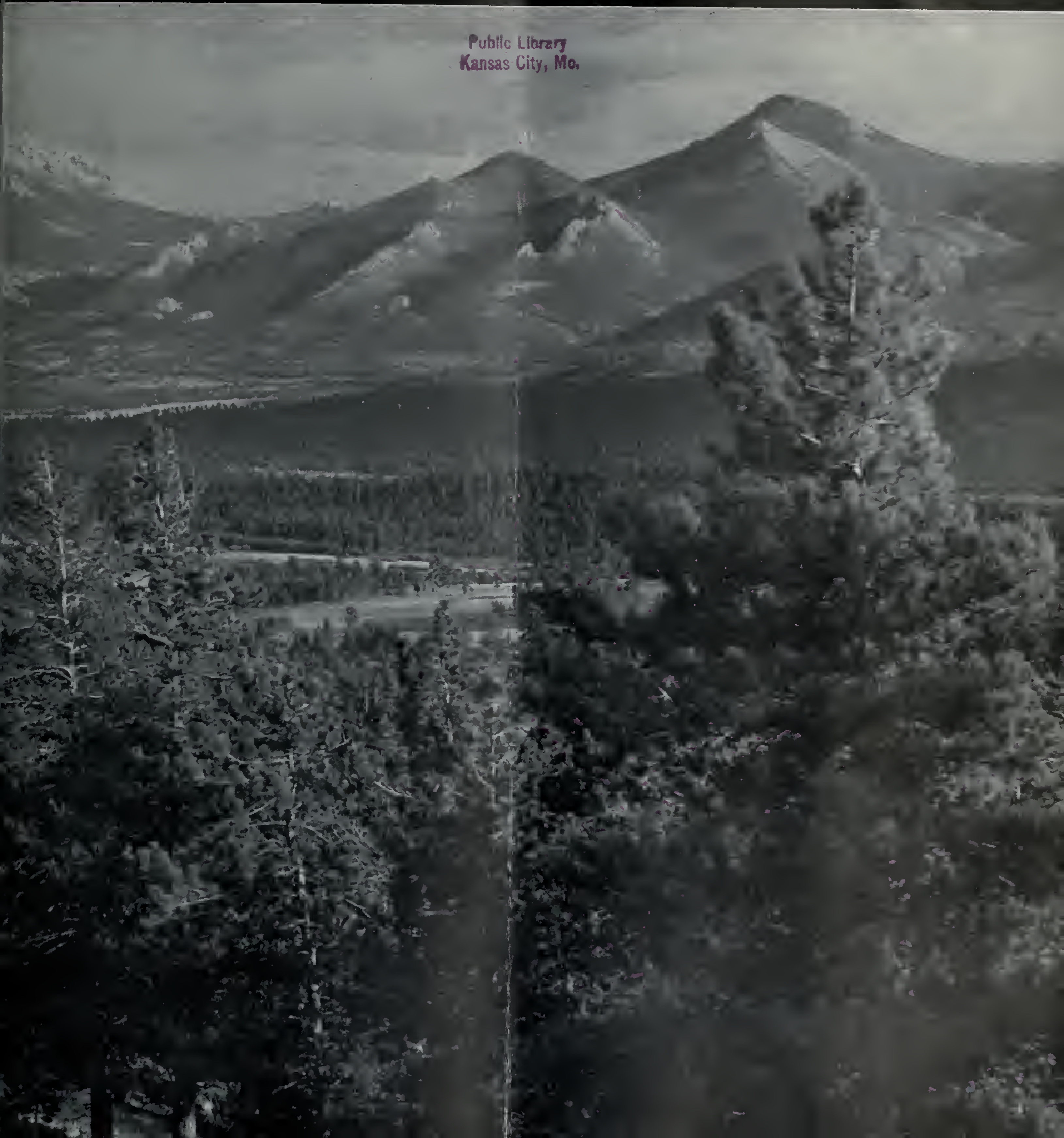

Sinclair O. Harper Appointed Chief Engineer

BY appointment of the Secretary of the Interior, Sinclair O. Harper succeeded Raymond F. Walter as Chief Engineer of the Bureau of Reclamation on July 18, 1940.

Mr. Harper, formerly Assistant Chief Engineer in the Denver office, has been Acting Chief Engineer since the death of Mr. Walter on June 30 at Fresno, Calif., during a visit to Friant Dam.

The following statement regarding Mr. Harper's appointment was made by Commissioner of Reclamation John C. Page: "I recommended Mr. Harper to the Secretary as the best available appointee for this important job. He has ably carried the full responsibility of the Denver office during Mr. Walter's absences from the office, and has always been the Chief Engineer's right-hand man. He has been with the Bureau for 33 years and has a thorough knowledge of irrigation construction. He is a sound engineer and a good administrator."

Mr. Harper is the fifth Chief Engineer in the 38 years since the Bureau of Reclamation was established by Congress on June 17, 1902, to develop the West by the construction of irrigation systems in arid regions.

The first Chief Engineer, F. H. Newell, served in that capacity until 1907 and then later served as Director. There followed A. P. Davis, 1907–20; F. E. Weymouth, 1920–25; and R. F. Walter, 1925 to 1940.

Mr. Harper entered the employment of the Bureau as a junior engineer on the Uncompahgre project in Colorado upon his graduation from the University of California with the degree of bachelor of science in civil engineering in 1907. He had been acquiring practical engineering experience while still in college, however, by working during summer vacations. He had already worked as a rodman and instrumentman for the Western Pacific Railway Co., as a transitman for the Pacific Improvement Co. of Monterey, Calif., and as the engineer in charge of designs and estimates for the sewerage system of Montrose, Colo.

His ability was quickly recognized after entering the service of the Bureau. Three months after his assignment as a junior engineer at Uncompahgre he was promoted to assistant engineer on the Grand Valley Reclamation project in Colorado, where he remained in charge of topographic and location surveys, the preparation of plans and estimates, and the construction of important features of the project from 1908 to 1917.

When the Grand Valley project went into operation, providing water for 35,000 acres of irrigable farm land, Mr. Harper was placed in responsible charge. He managed the project for 8 years, until 1925, when he was made general superintendent of all Reclamation construction and assigned to field headquarters at Denver, Colo.

At the time of this appointment, Chief Engineer Raymond F. Walter, said of him "There is no one better fitted by training, experience, personality, and ability for the position." Mr. Walter also informed the Bureau that Mr. Harper had refused several offers of more lucrative positions elsewhere because of his intense interest in the work of Federal Reclamation.

Mr. Walter leaned heavily on the new superintendent of construction for assistance in the increasing volume of construction work. Mr. Harper frequently acted as Chief Engineer in Mr. Walter's absences from the Denver office on inspection trips in the field, and 5 years after his appointment as general superintendent, urged by Mr. Walter, who characterized him as his "principal assistant," the Commissioner of Reclamation appointed Mr. Harper Assistant Chief Engineer, making his title fit the job.

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THE RECLAMATION ERA

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Convention of American Society of Civil Engineers

THE seventieth annual convention of the American Society of Civil Engineers, held in Denver, Colo., July 24 to 26, and attended by approximately 1,000 members and guests, was actively participated in by the Office of the Chief Engineer and by various members of the engineering staff, many of whom are members of the society. Some of the papers submitted were as follows:

- The Broad View of Reclamation. John C. Page, Commissioner, Washington, D. C.
- Project Construction. J. L. Savage, Chief Designing Engineer, Denver, Colo. (illustrated with lantern slides).
- Multiple Use Aspects of Irrigation Projects. E. B. Debler, Hydraulic Engineer, Denver.
- The Use of Models in Designing Outlets at Dams, With Particular Reference to Grand Coulee. J. E. Warnock, Hydraulic Engineer, Denver.
- New Solution of Stresses in Circular Plates. M. A. Seiler, Assistant Engineer, Denver.
- Earthquakes and Structures. R. E. Glover, Engineer, Denver.
- Consumptive Use of Water for Agriculture. Robert L. Lowry, Jr., Hydraulic Engineer, National Resources Planning Board, Roswell, N. Mex. (formerly Engineer, Bureau of Reclamation, Denver), and Arthur F. Johnson, Associate Engineer, Denver.
- New Theories and Concepts in Analytic Soil Mechanics. J. H. A. Brahtz, Senior Engineer, Denver.

Members of the Bureau staff also led and took part in open discussions in the various technical divisions.

It is expected that several of the papers presented will be published by the American Society of Civil Engineers, either in Civil Engineering or in the Proceedings of the Society.

Address by Chief Engineer Harper

"Mr. Chairman, members of the society, and guests:

"The Bureau of Reclamation is happy to have the opportunity to participate in the convention of the American Society of Civil Engineers, and to assist in welcoming you to Denver, the home of our central engineering office from which the Bureau's engineering and construction activities in the 17 Western States are directed.

"It is with deep sorrow that our organization is compelled to carry on this program without the leadership of our late Chief Engineer, Raymond F. Walter, who passed away on June 30 this year, after directing the activities of the Denver office for the past 15 years. We feel his loss keenly and his passing has left a void in our organization and in our hearts which will be difficult to fill.

Cover: **Scenery in Rocky Mountain National Park enjoyed by many attending the annual convention of the American Society Civil Engineers.**

Convention Dates Set

Western State Engineers.—**Great Falls, Mont., September 22–23.**

National Conference on Land Classification.—**University of Missouri at Columbia, Mo., October 10–12.**

"The Bureau of Reclamation was established in 1902, to further the development of the land and water resources of the arid West. During the early years the field operations were directed through a number of district or supervising engineers' offices. The Denver office was established in 1915, and since that time all field operations of the Bureau have been directed from here.

"In 1927, when the last annual convention of the society was held in Denver, the personnel of the Denver office consisted of 62 employees. In 1930, after the construction of the Boulder Canyon project was entrusted to our organization, the force was increased to 200. In 1933, with the undertaking of numerous additional projects for which emergency relief funds were allocated, the organization was rapidly expanded to over 500. With the undertaking of Grand Coulee Dam, it was necessary to again enlarge the force to 750 by 1935; and finally, to handle the increased volume of work incident to the Central Valley project in California and other new projects, expansion was made to the present organization of approximately 950. In 1927, the average annual expenditures on construction work directed by the Denver office were about $8,000,000. During the fiscal year 1940, just ended, the expenditures had increased to $95,000,000, the greatest for any single year.

"I hope you will pardon me when I say that distinguished engineers acquainted with our work have expressed the opinion that we have in our Denver office the finest group of engineers ever assembled in one place. Of our total force of 950, 550 are graduate engineers, representing 132 American and 12 foreign universities. These institutions include practically every important university and technical school in the United States. We also have in the Denver office organization 138 members of the society.

"I hope during your brief stay in our city that you will become better acquainted with our work.

"We are particularly favored to have with us today our Commissioner, John C. Page, who has come from Washington to participate in this program. During the 4 years he has occupied this position, he has established reclamation on a sounder basis than ever before, and has made an enviable record in securing nonpolitical support in Congress for the continuation of a well considered reclamation program. Mr. Page is not only a member of the society, but he also holds the office of president of the local section at Washington, D. C. I take great pleasure in presenting to you Commissioner Page."

The Broad View of Reclamation

By JOHN C. PAGE, *Commissioner of Reclamation*

IRRIGATION of arid lands in the United States under the Federal Reclamation law is a double-barreled enterprise. It is a social program as well as a business proposition. It creates opportunities for the establishment of new homes and it develops the Western States which have been carved from the 700 million acres of arid and semiarid lands within our national boundaries.

This combination social and physical development makes good common sense. Older nations have recognized that fact. Down through all recorded history, those nations situated in dry climates have viewed irrigation as a responsibility of the state. The world's oldest civilizations grew in irrigated fields and after thousands of years they are still flourishing in the irrigated valleys of Egypt, Syria, Persia, and India.

On this continent before the time of Columbus, the Indians were irrigating fields of corn in the Southwest. The Spanish missionaries brought with them to the Southwestern deserts from the lands bordering the Mediterranean knowledge of irrigation methods and practices which they planted in American soil.

The Anglo-Saxon stock which dominated in the early settlement of the Atlantic seaboard and which participated in the expansion westward, had no experience in arid climates. Nevertheless when it came into the arid and semiarid lands west of the 100th meridian, it quickly adapted itself to the new conditions, as evidenced by the introduction of irrigation by the Mormons in Utah in 1847. The Mormon settlements could not have been supported on the shores of the great Salt Lake except by irrigation.

It is regrettable that there was no irrigation lore among the folk who founded the United States. The common law of England, recognizing riparian rights, hardly was appropriate in arid and semiarid climes. The founders of the new nation which declared its independence in 1776, fighting a war in the humid, verdant valleys east of the Allegheny Mountains to make that declaration stick never foresaw that the United States would cover a vast arid domain far larger than the area of the 13 original colonies.

Because of these facts the United States was slow in assuming its national responsibility in connection with irrigating and developing its arid lands. Initial successes and final failures of other methods of settlement and development of these arid lands had, therefore, to precede Federal action. Even today, 38 years after reclamation was adopted as a national policy, there is a general lack of understanding in the populous, humid areas, where settlements are older, of the conditions and the problems in the West which make irrigation necessary, and a lack of appreciation of the objectives and the achievements of the Federal reclamation program.

Reclamation's Contribution to the Nation

It is true that the United States could have become a great nation without irrigation, for two-thirds of its territory is humid. But it never would have become so great a nation as it is today without the 20,000,000 acres of irrigated land in these Western States. The economic destinies of more than 13,000,000 people in this arid region and great cities, such as Los Angeles, Phoenix, Salt Lake City, and Denver, rest upon farming by irrigation and the industrial growth made possible by conservation of water. Our irrigation projects are the piers on which the transcontinental railroads bridge the deserts of the West.

The story of this western development parallels the evolution of irrigation in the United States. After the Mormons diverted the waters of City Creek, and before the Federal Reclamation Act was passed, simple and easy water diversions were made from hundreds of creeks and rivers in the West. By 1900, 8,000,000 acres were irrigated as the result of individual, corporate, cooperative, and State enterprise and a population of 4,000,000 was being supported in this western third of our country.

By 1902 most of the easy diversion had been completed. Most of the remaining opportunities for developments required construction of storage dams, costly canals, and other works with which the Federal Government alone could cope. On June 17, 1902, the Federal Reclamation Act became law, culminating more than half a century of experimentation; half a century during which private financing of intricate irrigation developments was proving wholly inadequate; half a century which saw half-measures tried.

The entry of the Federal Government into the field stimulated other investments as well. There was a rapid expansion of irrigation, only a part of which is the direct result of Federal activities. Large areas were watered by pumping from underground sources, particularly in California. Irrigation projects already in existence were expanded. Some entirely new projects using surface waters were developed by irrigation districts. For the last 15 years, however, the Federal Government has been virtually the only agency engaged in irrigation development.

In less than four decades, the Bureau of Reclamation has placed works in operation to serve nearly 4,000,000 acres of land. Of this total approximately 2,500,000 acres were once unproductive desert, and 1,500,000 acres were in non-Federal irrigation districts which had inadequate water supplies. Today it has a great construction program, the largest in the Bureau's history, which will provide water to about 2,500,000 additional acres, transforming them from sagebrush wastes into productive farms that will support a million people. This will bring to 5,000,000 acres the total of new lands the Bureau has watered.

Equally as important as the irrigation of new lands is the provision of supplemental water for areas already irrigated. Water tables lowered by overdrafts on underground supplies, unanticipated droughts, and inadequate storage facilities threaten many areas with desolation or stagnation. Stabilization or succor of these communities is vital to the public welfare. Rehabilitation projects, therefore, make up about half of our present program. They will serve 3,500,000 acres, including a great area in the pumping section of central California. They will bring to almost 5,000,000 acres the lands which will have been rescued by the Federal Government.

Large Acreage Still May Be Irrigated

Many of the developments which will be made in the future will require engineering works of great size and complexity, and most of them will be on interstate streams or in the main stems of the large rivers. The Bureau of Reclamation estimates that perhaps as much as 20,000,000 acres additional can be irrigated with water resources as yet undeveloped and under policies now in effect. The future growth of the West will be correlated in large measure with the conservation of these remaining water resources and their beneficial use.

In the future, as in the past, the Bureau will build sound structures. Reclamation projects are considered permanent national assets, and so durability must be an objective of project construction.

The original basis on which irrigation was undertaken by the Federal Government was that 90 percent of the revenues from the sale of public lands should be used for irrigation in the Western States. The settlers on the irrigated projects were required to repay the cost, without interest, of the construction of the works serving them. The public land

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Denver Office Holds Open House

For the American Society of Civil Engineers and the Radio Public

IN the laboratories where practical designing investigations have led to many engineering advances, the Denver engineering office of the Bureau of Reclamation in July held open house for 750 members of the American Society of Civil Engineers and for a Nation-wide radio audience.

The society, during its convention in Denver, made a special feature of the inspection of the laboratories, giving the full afternoon on July 26 to it. The radio broadcast on July 25 was put on by Denver's station KFEL and the Mutual Broadcasting System, coast to coast, as a half-hour special events feature. More than 2,000 persons visited the laboratory, where photographic displays, working models of great dams, special apparatus developed in the laboratory for testing materials, and many other exhibits were on view.

The visiting engineers were particularly interested in a delicate tiltmeter, an exhibit of concrete which had been poured against absorptive form lining, tests being made in

L. J. Svendrup tries the tiltmeter

Mr. Ford explains exhibit on physical properties of cement to Mr. Bonavies; Dean Samuel B. Morris, School of Engineering, Stanford University; and A. L. Proske

Left: Messrs. Blanks, Welch, Warne, and Harper during broadcast. *Center:* Mr. Welch holds the portable microphone for Colonel Hogan. The large testing machine has just broken an 18-foot concrete cylinder, as may be seen in the background. *Right:* Mr. Welch and Commissioner Page close the broadcast

the hydraulic laboratory, and laboratory methods. A large model of the Colorado River in which Boulder Dam is shown in relation to the area it serves, and an 8-foot scale model of Shasta Dam as it will appear when completed in about 4 years were outstanding attractions.

The broadcast was conducted by William Welch, manager of special events and newscaster for KFEL. It opened with the shattering of a concrete cylinder 18 inches in diameter by application of 1,750,000 pounds of pressure in the great laboratory testing machine. Sinclair O. Harper, Chief Engineer, Bureau of Reclamation, Col. John Hogan, president, American Society of Civil Engineers, and John C. Page, Commissioner, Bureau of Reclamation, each spoke briefly to the radio audience concerning the laboratories and the work done there, while Emile N. Vidal, engineer, Robert F. Blanks, senior engineer, and William E. Warne, Director of Information, of the Bureau's staff, assisted Mr. Welch in describing the laboratories.

Mr. Harper welcomed the engineers and public to the laboratories, saying:

"In the basement of the United States Customhouse here in Denver, the Bureau of Reclamation maintains its laboratories where materials which go into such great dams as Boulder, Grand Coulee, and Shasta are tested; where designs are tried out on actual small scale models; and where practical scientific research is conducted. This laboratory, or rather this series of laboratories, for there are several here, is in truth a part of the engineering design work. The Denver office of the Bureau of Reclamation designs and supervises all the construction of projects in the 17 Western States. Here more than 550 graduate engineers are employed. The laboratories embrace one important phase of the design work, but not particularly large in comparison with some other sections.

"When little dams would do the work that needed to be done, the rule of the thumb played as large a part in their construction as did engineering principles and theories. When larger structures were needed, more precise methods were required. We found we had to know more about how water acted in going over a spillway, how concrete behaved when it was embedded in the middle of Boulder Dam, how water percolated through various soils in earthen dam construction. We studied those things here.

"President Hogan of the American Society of Civil Engineers, the Bureau of Reclamation has thrown open its laboratories today to the public because your society is holding its seventieth annual convention in Denver. We are showing the engineers what we have found out and what we are studying. We are a Government agency and such knowledge as we gain belongs to and should be used to benefit everybody. I welcome the members of the American Society of Civil Engineers here, and through the facilities of station KFEL and the Mutual Network, I invite all to inspect the laboratories of the Bureau of Reclamation."

In response, Col. Hogan said:

"As president of the American Society of Civil Engineers and on behalf of its thousands of members, I wish to congratulate the United States Bureau of Reclamation, and the chief engineer, Mr. Harper, on the wonderful scientific exhibition which we are now previewing. It is particularly fitting that the Civil Engineers should hold their seventieth annual convention in the city of Denver, the headquarters of the greatest Government construction bureau, and discuss here the technical problems which confront them.

"If you draw a North-South line through the middle of Nebraska, you will find that, with the exception of the Pacific Northwest, most of the country west of this line is semiarid and agriculture furnishes only a precarious livelihood. In many places, however, the soil is very fertile and needs only water to raise surprising crops. It has for 40 years been the business of the Reclamation Service to store the snowfall in the Rocky Mountains and distribute the water over the areas.

"How well this work has been done is demonstrated by the fact that the reclamation works are models for similar works all over the world and have been visited frequently by engineers from every country in the world.

"Their engineering works include at least two which may be properly classed among the seven wonders of the world and the net result has been a great addition to the permanent and indestructible wealth of America. All of these great structures did not just grow 'like Topsy.' They were the result of the patient research and experiments conducted in these laboratories which will be explained to you.

"In these days of war and destruction, I believe we, as Americans, should all rejoice in saluting one of the greatest of peace-time achievements with 'Hats off to the United States Bureau of Reclamation.'"

The Commissioner closed the broadcast as follows:

"You have just been through the laboratories of the Bureau of Reclamation where engineering designs are investigated and sometimes improved. The Bureau, an agency of the United States Department of the Interior, has built about 160 dams furnishing irrigation water to more than 3 million acres of land which thereby have been reclaimed from the desert and now support more than a million people. This work has been going on for 38 years. We are now engaged in an expanded program which will make homes eventually for nearly an additional million people. The Bureau operates in 17 of the large, dry Western States; that third of the Nation which is arid or semiarid.

"The Bureau is proud of its engineering record. It builds for permanence and never has lost a dam. It is proud also of the fact that its work gives people the opportunity to make successful new homes; helps to build and to stabilize these Western States and the Nation; and returns to the Treasury through payment for water and power the cost of its construction.

"I hope you have found the work of the laboratories interesting. I can assure you it is important. Here have been discovered ways of reducing the cost of many types of structures, making them serve more efficiently, and at the same time increasing the length of their useful life.

"These laboratories are the tools of the designing engineers. Problems arising in the design of dams and other structures of unprecedented size are often worked out here through study and experiment with models made precisely to scale. Theoretical solutions are tested in practical situations. To give an example, on one great dam model tests improved the spillway design and at the same time reduced the cost of construction of the spillway by half a million dollars.

"We can say pretty accurately as a result of the work done here that our big dams are permanent, useful improvements. Our children should be able to admire and use such structures as Boulder and Grand Coulee Dams at a time so distant in the future that they will have difficulty in tracing their family trees back to our time."

Black Canyon Canal Structures

CONTRACT for the construction of two wasteways on the lateral system of the Black Canyon Canal which will serve the new Payette Division of the Boise project, Idaho, was awarded on August 21 to Vernon Brothers Co. of Boise on its low bid of $84,572.50.

The contract covers earthwork and structures for the Graveyard Gulch and the Langley Gulch wasteways. It involves the excavation of 356,000 cubic yards of materials; the construction of concrete drops and chutes, canal, highway and railroad crossings, bridges, drains, inlets, and other structures.

The Black Canyon Canal, with an initial capacity of 1,909 second-feet, heads at the Black Canyon Dam and runs west for a distance of about 30 miles. Its route follows the southern edge of the Payette Valley, first through the orchards on the Emmett Slope and then along a steep hill near Plymouth, where it crosses the Payette-Boise summit. There the canal divides into two branches, the A and D line canals, which continue westward along the Boise and Payette Slopes. The Graveyard Gulch wasteway extends north from the Black Canyon Canal just before it branches and crosses the Payette Valley branch of the Union Pacific Railroad. The Langley Gulch wasteway extends north from the A line canal to a point near New Plymouth.

Work on the main canal is completed and construction of the lateral system is under way. This new Payette Division will add 47,000 acres to one of the oldest and largest Federal Reclamation projects.

Reclamation

(*Continued from p. 246*)

revenues and the repayments by the settlers were set aside as a Reclamation revolving fund.

This was considered a good business proposition on the part of the Federal Government, and, in my opinion, it has proved to be exactly that.

Reclamation a Paying Investment

Reclamation projects completed and now operating as a result of this policy have repaid more than $62,000,000 of the cost of the works serving them. They support more than 1,000,000 people on some 70,000 farms and in some 258 project towns. They produce more than $100,000,000 of new wealth annually. They have produced more than 2½ billions of dollars of new wealth since they first started operation. They have created and are protecting taxable values in excess of $4,500,000,000. They provide an annual market for produce and manufactures of the humid areas worth more than our foreign trade with many countries which are considered prime markets for American goods.

Let me repeat these facts. They are worth repetition. Homes and a chance for a good livelihood for a quarter of a million American families. A crop production valued at $100,000,000 a year. A market for American industry worth $200,000,000 a year. Taxable property carved out of lonely desert totaling more than $4,500,000,000. This is what Reclamation has brought to the country.

From the first, however, the Congress has looked on the Federal Reclamation program also as a social program. It directed that settlement be on family-size farms. It has written into the law from time to time provisions to prevent speculation in project lands and to protect the settlers. It directs that in selling surplus power from project plants preference shall be given to publicly owned or cooperative distributors. It declared this year "that, in the opening to entry of newly irrigated public lands, preference shall be given to families who have no other means of earning a livelihood, or who have been compelled to abandon, through no fault of their own, other farms in the United States, and with respect to whom there is a probability that such families will be able to earn a livelihood on such irrigated land."

The present practices and methods of the Bureau of Reclamation, even the present method of financing the construction and the large multiple-purpose project, are also the products of evolutionary processes.

The Reclamation Act of June 17, 1902, was brief. It contained only a few hundred words. Subsequent legislation making up the body of the Federal Reclamation law, however, together with interpretations, make a volume of several hundred closely printed pages. There have been no startling innovations, however, in this body of law. The original principles—economic feasibility and reimbursability—still govern. For the most part, only logical extensions have been made as changing conditions have dictated.

When the sales of public lands diminished and virtually ceased, other revenues, such as a portion of the royalties from oil and minerals taken from the public lands, were added to the reclamation fund. When it was found that reservoirs being constructed to serve Federal project lands could also be made to provide supplemental water to projects already in existence, provisions were made by which water could be supplied under adequate contracts to those areas. When it evolved, with the construction of large dams, that power could be generated, a measure of flood protection provided, and navigation served in addition to meeting irrigation storage requirements, intelligent and constructive steps were taken to authorize consideration of and the planning for these multiple and related functions.

It obviously is appropriate that the Federal Government should insure a wide distribution of the benefits of these works built in the public interest. These advances were made step by step to that end.

In recent years, beginning with the institution of the first major public-works program, the reclamation fund has been supplemented and augmented by allotments and appropriations from other sources. Construction financed by the reclamation fund has cost $265,000,000. In addition, allotments from emergency funds totaling $190,937,000 have been made and $324,540,000 have been appropriated from the General Treasury. The allotments from the emergency funds for reclamation projects are also reimbursable and about 25 percent of the total expenditure is chargeable to power and will be returned with interest at a rate not less than 3 percent. Projects like Boulder Dam, Grand Coulee Dam, and the Central Valley project in California never could have been financed wholly from the reclamation fund. I consider each of these, however, wholly justified in the public interest and it is appropriate that general funds have been made available for their construction.

President Theodore Roosevelt told Congress in 1901, "It is as right for the National Government to make the streams and rivers of the arid region useful by engineering works for water storage as to make useful the rivers and harbors of the humid regions by engineering works of another kind."

This cannot be questioned. Historic as is the policy of river and harbor improvement for navigation, however, I do not mean to imply that the justification of Federal Reclamation rests wholly on this comparison.

The work of conservation and utilization of the precious water resources of the West stands firmly on its own feet.

While other peoples make terrible wars for expansion, we have only to build great works to provide ourselves with elbowroom. This constructive endeavor, which will more than pay its own way through direct returns to the common treasury and increases in taxable wealth, pays dividends in future security as well. I see in these great water projects and the developments which go with them ramparts which will guard our civilization and which may serve it as well as have the canals served Egypt which were built more than 4,000 years ago.

Crane Prairie Dam Completed

CONSTRUCTION of the Deschutes project, Oregon, was authorized by the President November 1, 1937, and began on September 19, 1938. The irrigation plan of the development provides for the storage of Deschutes River water in two reservoirs—Wickiup, with a capacity of 180,000 acre-feet, and Crane Prairie—for distribution through a 65-mile main canal and a lateral system.

Construction at Crane Prairie Dam is virtually completed. All that remains to be done is the completion of the upstream protection on the spillway, the excavation of the river channel to final grade upstream from the dam, the placing of the screen fabric on the fish screen and the final clean-up.

The completion of the dam will create a reservoir which will provide a capacity of 50,000 acre-feet, or about 16 billion gallons of a much needed supplemental water supply for 47,500 acres of land near Bend, Oreg.

The lands to receive the supplemental supply are in the long-established irrigated areas of the Central Oregon Irrigation District, the Arnold Irrigation District, and the Crook County Improvement District No. 1.

The irrigation districts built their own irrigation system years ago but have developed and grown beyond the capacity of the system so that the farmers were unable to obtain a share of the available water supply sufficient to take care of their crops.

The contractor's price for the dam, erected under the supervision of Bureau engineers, was approximately $104,000. The cost of the dam plus other features of the project, including Wickiup Dam which is still under construction, will be repaid under a 40-year contract by the water users.

Crane Prairie Dam is an earth-fill structure with rock facing. It is 40 feet high, 200 feet thick at the base, and 280 feet long at the crest. It has a volume of 28,000 cubic yards.

As on many Reclamation projects, provision is made for the protection of fish life. Included in the Crane Prairie Dam contract was the construction of a concrete and steel fish screen and control structure. Fish screens in Reclamation reservoirs prevent fish from passing into the canals which carry the water to the farm fields.

Salt Lake Aqueduct

Provo River Project, Utah

By C. B. JACOBSON, *Assistant Engineer*

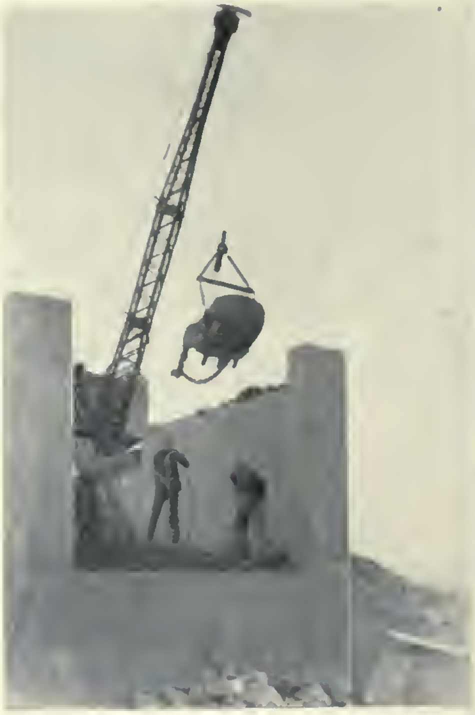
RECENTLY added to the large field of construction activities by the Bureau of Reclamation is the 40-mile aqueduct between Deer Creek Dam and Salt Lake City. Participation in this phase of irrigation development marks the entrance of the Bureau into the field of extensive pipe-line construction. The Salt Lake Aqueduct, comprising 3½ miles of concrete-lined tunnels, 36 miles of concrete and steel pipe conduit, and numerous structures, is estimated to cost $5,800,000.

The purpose of the aqueduct is to convey storage water from the Deer Creek Reservoir to Salt Lake City and its suburban area for irrigation and domestic uses. It is interesting to note that the area now included in the Provo River project, which will benefit by a supplemental irrigation supply, was the scene where modern irrigation practice began in July 1847. Since that time Salt Lake City has become an important center of industry and activity with a present population of 140,000 people. Through the application of water from the many nearby mountain streams, the suburban lands surrounding the city have developed into highly cultivated areas. Through necessity this development and growth was paralleled by a conservative and economical use of the various sources of water supply.

The storage water of Utah Lake, which normally spilled its high water into the Great Salt Lake through the Jordan River, was utilized by various irrigation interests through the use of a small regulatory dam at the outlet. Salt Lake City later installed a pumping system whereby water could be obtained from Utah Lake during the season of low stage in order to effect an exchange with the owners of mountain stream water, a more potable source for municipal purposes. The city also built several small dams and reservoirs for the storage of flood waters. However, the inadequacy of these supplies has been evident for several years. Realizing that the future growth and prosperity of the city and its suburban area is largely dependent upon an insured water supply, this community has been diligently seeking a long-time water plan, one which will not only eliminate the shortages of the present droughts, but will also provide for future industrial and municipal expansion and for the development of the adjoining suburban areas.

Need for Supplemental Water

The drought period of 1931–35 brought about a full realization that the available supply within the immediate watershed was inadequate. The city was unable to fill its small reservoirs, having an aggregate capacity of 5,100 acre-feet. Utah Lake, with a normal capacity of 850,000 acre-feet, was down to a mere 20,000 acre-feet. The situation was further aggravated when the city was unable to meet its exchange agreements with the various irrigation interests, which in turn demanded the full flow of the scanty streams in order to avoid very serious shortages. In a desperate attempt for relief, the city turned to the development of artesian and deep-well systems, but this supply proved very costly and was also quite limited. Of the various schemes investigated, the plan of subscribing for storage in the Deer Creek Reservoir of the Provo River project was found to furnish a present adequate water supply for Salt Lake City and adjoining suburban area, and more important, to provide a reserve for many years of future growth.



Concrete bent and abutment for self-supporting 72-inch diameter steel pipe span used over natural drainage channels

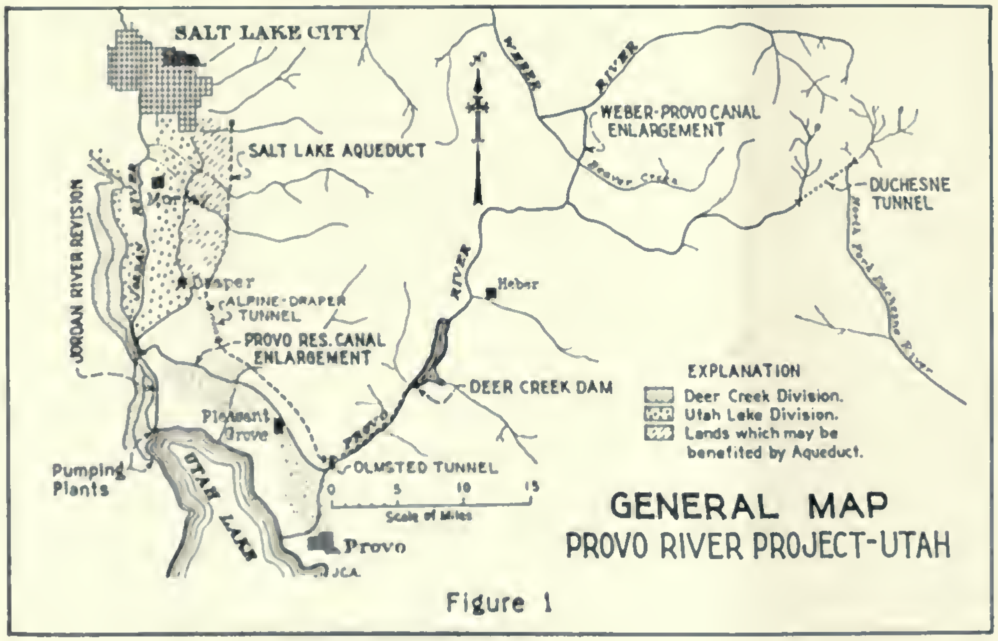


Figure 1

The Salt Lake Metropolitan Water District subscribed for 46 percent of the estimated mean annual yield of storage supply for the Deer Creek Reservoir amounting to 46,000 acre-feet per year. The most feasible plan for the delivery of this supply to the city and the adjoining suburban area provided that the city, through its Metropolitan District, would contract for building a covered conduit from the reservoir direct to the city at the highest elevation practicable to insure the coverage of as large an area as possible. Many years will elapse before Salt Lake City can fully utilize its total Deer Creek Reservoir subscription for municipal and domestic purposes; therefore, it will prove advantageous for the city to lease for supplemental irrigation, its unused water to the agricultural interests in the suburban area adjoining the city limits.

Permanent disposal of the district's water is prohibited by the Metropolitan District laws of the State of Utah; however, long-time agreements are to be made with the outlying districts. As the city expands, much of the adjacent suburban area will be incorporated within its boundaries, which will result in a transition from agricultural to municipal and domestic use of the major portion of the district's water. Further, it was found infeasible for the irrigators to participate in the project if required to meet their portion of the entire initial cost. On the other hand, possibly over a period of 75 years when the city will ultimately require its full subscription, Salt Lake City will derive a yearly revenue from the sale of its reserve supply and will greatly benefit through the added prosperity of its suburban areas brought about by its well-balanced long-time water plan.

The Deer Creek Reservoir is located in Provo Canyon about 17 miles northeast of Provo. The distance from the reservoir to Salt Lake City is 28 miles by airline and in excess of 50 miles along the aqueduct. It was desirable to divert from the reservoir at elevation 5.274 and enter the existing distribution system of the city at elevation 4,920. Many problems in design, geology, and general construction methods were encountered in determining the location (fig. 1) between the intake and terminus of the aqueduct. Pipe capable of withstanding pressure heads up to 300 feet is required. Many structures are necessary to convey the pipe line across dry ravines which, at times, carry cloudburst torrents.

In the Provo Canyon section the conduit will traverse the canyon floor and require provisions against damage by mud flows and snow avalanches which are so prevalent in this area. The Bonneville Terrace, a topographic remnant of prehistoric Lake Bonneville along the western face of the Wasatch range of mountains, was used to great advantage for the location of the conduit while at other points, tunnels and high-head siphons will provide shorter routes. Although no movement is anticipated along the Wasatch Fault line which forms the face of the Wasatch Mountains, paralleling the aqueduct in general, an extensive geologic study was made and the location selected to avoid the fault line except where absolutely necessary. These are but a few of the many details which must receive consideration in order to secure uninterrupted service so valuable to a municipality and farming community.

Twenty-foot section of test pipe, weighing 20 tons, being loaded onto special trailer

Construction of the Salt Lake Aqueduct was started early in 1939 on the Alpine-Draper and Olmsted Tunnels. Both tunnels have a concrete lining 7 inches thick and are 6½ feet inside diameter horseshoe sections. An article describing construction equipment and methods was published in the June 1939 issue of the ERA. The Olmsted Tunnel, 3,600 feet long, was completed in November 1939.

Pipe plant of Utah Concrete Pipe Co. Placing inner reinforcing cage for 20-foot section of test pipe for Sale Lake Aqueduct

A contract covering an 8-mile section of pipe line and structures of the aqueduct was awarded on August 29, 1939, to the Utah Concrete Pipe Co. on a low bid of $522,353.27. The section under construction extends from the outlet portal of the Olmsted Tunnel at the mouth of Provo Canyon north to American Fork Creek and is made up of low-head precast reinforced concrete pipe units having an inside diameter of 69 inches and a wall thickness of 7½ inches. The pipe units, the length of which is optional with the contractor, are to have a bell-and-spigot type of joint. After being set in the trench a continuous rubber gasket will be pulled over the spigot end and held in a recess cast in the pipe. The units will then be drawn together and the watertight joint completed by field calking and grouting operations. Special care is required in the preparation of the foundation upon which the pipe rests and in the backfilling of the trench to prevent settlement or movement of the pipe. The pipe, except where carried on concrete bents over natural drainage channels, will rest in a trench having an average depth of 11 feet, and is to be covered with a minimum of 3 feet of earth.

Other sections of the line are to be advertised for construction from time to time as funds are made available. A separate contract dated November 16, 1938, was executed by the United States and the Metropolitan Water District of Salt Lake City covering the repayment of construction costs of the aqueduct.

Inauguration Ceremonies for Continental Divide Tunnel

Colorado—Big Thompson Project

WORK was officially started on the Continental Divide Tunnel of the Colorado Big Thompson project, Sunday, June 23, 1940, at 3 o'clock, p. m.

The official starting of the tunnel ceremony was held through the cooperation of The Northern Colorado Water Conservatory District, The Bureau of Reclamation, and S. S. Magoffin, contractor. At 2 p. m., approximately 2,500 people had gathered at the site of the east portal of the tunnel where the ceremonies were to be held.

A descriptive story was first broadcast over radio station KFKA, located at Greeley, Colo., which is in the heart of the conservancy district. George A. Irwin, president of the Greeley Chamber of Commerce, acted as chairman and introduced the following speakers:

Dr. Charles A. Lory, president, Colorado State College of Agriculture and Mechanic Arts, Fort Collins, Colo.

S. O. Harper, Chief Engineer, Bureau of Reclamation, Denver, Colo.

Porter J. Preston, supervising engineer, Colorado-Big Thompson project, Estes Park, Colo.

Other speakers included S. S. Magoffin, president, and Frank Purvis, superintendent of the Magoffin Construction Co.; Cleves H. Howell, construction engineer, Continental Divide Tunnel, Bureau of Reclamation, and Charles Hansen, president, Northern Colorado Water Conservancy District. Mr. Hansen read congratulatory messages from the Colorado congressional delegation, Secretary of the Interior Harold L. Ickes, and State officials.

While the 2,500 spectators stood and cheered under a blazing Colorado sun, Mr. Hansen closed an electric switch and a series of heavy muffled booms together with vivid flashes at the tunnel portal officially proclaimed that the tunnel work was under way.

After a few minutes wait for the powder fumes to clear away, the spectators were allowed to go forward and inspect for themselves the results of the official shots.

Many of the interested spectators and those who have been actively engaged in bringing this project to the construction stage, emerged from the portal with large pieces of rock to keep as souvenirs of a large undertaking finally under way.

Upper: East Portal of Continental Divide Tunnel, with spectators going forward to view results of official starting shots. *Center:* The official shots have been fired and the crowd is waiting for fumes to clear before inspecting the tunnel. *Lower:* Porter J. Preston, Supervising Engineer of the project, delivers address to visitors at tunnel ceremonies.

Origin of Names of Projects and Project Features in Reclamation Territory

Boulder Canyon Project, Arizona-Nevada-California[1]

Boulder Canyon project.—The name was derived from Boulder Canyon, deep gorge in the Colorado River more than 450 miles above its mouth and just below the confluence of the Virgin River. Popularly designated as the Boulder Canyon project and so mentioned in numerous reports in the years preceding the enactment of legislation authorizing the construction, the act of December 21, 1928, specifically bestowed the name, Boulder Canyon project.

Boulder Dam.—The dam, 440 miles above the mouth of the Colorado River, took its name from the project. Although constructed in Black Canyon (sometimes mistakenly referred to as lower Boulder Canyon), Boulder Dam was the name in common use during the planning period, and on July 4, 1930, Secretary of the Interior Ray Lyman Wilbur ordered work to start on Boulder Dam. Later, in September 1930, Secretary Wilbur designated the dam "Hoover Dam," but this designation was superseded in May 1933 by order of Secretary of the Interior Harold L. Ickes, who restored the original name, Boulder Dam, to eliminate confusion.

THIS, the fourth in the series of articles on the above subject, includes the following projects: Boulder Canyon, Salt River, Grand Valley, North Platte, Tucumcari, and Pine River projects.

Boulder power plant.—The power plant was named for the project and the dam.

Boulder City.—The Government town in Nevada derived its name from the project.

Lake Mead.—The reservoir created by Boulder Dam was named for Dr. Elwood Mead, Commissioner, Bureau of Reclamation, 1924–36.

Las Vegas, Nev.—This name was given because of the desert oasis in which it is located. In the early 1800's it was known as Las Vegas De Quintanos. Las Vegas, the

Above: Boulder Dam impounds Lake Mead, the longest man-made lake in the world—115 miles

Below: Aquaplaning on Lake Mead

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[1] Much of the information concerning the origin of names on this project as herein given was taken from the book Place Names in Arizona, by Will C. Barnes, published by the University of Arizona. Pioneers in this area were also of great help in some few cases.

Spanish for meadows, was undoubtedly called Quintanos Meadows after Quintanos, an early Mexican trader.

Kingman, Ariz.—This small town on the Santa Fe Railroad about 72 miles from Boulder Dam, was named after Lewis Kingman, locating engineer for the railroad. A post office was established there on March 22, 1883.

St. Thomas, Overton, Logandale, and Kaolin, Nev.—These small communities in the Muddy and Virgin River valleys were settled by the Mormon Church about 1835. St. Thomas is believed to have been named after the biblical character, St. Thomas. The origin of Overton is unknown. Logandale was named after the Logan family, among the first settlers in the area. Kaolin derives its name from a deposit of kaolin near the town site.

Fort Callville.—Anson Call, of the Mormon Church, established this fort on December 17, 1864. The remains of the fort are located on the Colorado River just downstream from Boulder Canyon at a point which was considered the head of early day navigation upstream. This point is now covered by Lake Mead.

Pierce Ferry.—This ferry, located on the Colorado River near the lower end of Grand Canyon at the mouth of the Grand Wash, was established in December 1876 by Harrison Pearce, for whom it was named, although the spelling of the name was changed in placing it on all maps.

Bonelli's Ferry.—So named for Daniel Bonelli, an early settler in the Virgin River valley. This ferry was located on the Colorado River near the mouth of the Virgin River.

Gregg's Ferry.—Established on the Colorado River between Iceberg and Virgin canyons, by a man named Gregg. The date of establishment, however, is unknown.

Virgin River.—"Rio De La Virgen," River of the Virgin. Undoubtedly the name was given by early Spanish explorers. The river rises in Kane County, Utah, flows southwest through the northwest corner of Arizona into Nevada, and joins the Colorado River in Clark County at Boulder Canyon. Ives in 1857 and Powell in 1867 spelled the name Virgen, which spelling no doubt came from Escalante, who in 1776 named and spelled it Rio De La Virgen.

Muddy River.—This river, which contrary to its name never could have been called muddy, probably was first seen at a time of high water when discoloration by silt might have been noted, thus suggesting the name. The stream, in Paiute County, once a part of Arizona, now Clark County, Nev., traversed that part of the State which was settled in January 1865 with several Mormon towns, probably St. Thomas, Kaolin, Overton, and Logandale. Muddy River is a branch of the Virgin River.

Las Vegas Wash.—This large wash on the Nevada side of the Colorado River between Black and Boulder Canyons, received its name from the town of Las Vegas.

Detrital Wash.—This long and wide valley on the Arizona side of the Colorado River was so named because of its geological characteristics.

Hemenway Wash.—A wash on the Nevada side of the Colorado River just above Black Canyon, probably named after an early day prospector.

Grand Wash.—A deep gorge in the extreme northwest corner of the State, extending southwest to the Colorado River near the Arizona State line at Iceberg Canyon, named after Grand Wash Cliffs, which form the lower end of Grand Canyon.

The Temple.—A rock formation on the Colorado River near Virgin Canyon, which resembles an old temple.

The Campanile.—A rock formation across the river from The Temple, having the appearance of a tower or steeple.

Virgin Canyon.—This, the first canyon on the Colorado River upstream from the mouth of the Virgin River, probably was named after the Virgin River.

Iceberg Canyon.—On the Colorado River, just downstream from the mouth of the Grand Wash, named in Wheeler's Report of 1871 with the following statement: "Passing through a small unnamed canyon, we applied the term 'Iceberg' to it on account of the contour of its northern walls."

Emery Falls.—Located in a small canyon at the lower end of Grand Canyon, now covered by Lake Mead; discovered by the Emerys about 1926. The Emerys were able, with a "Stern Wheeler" boat, to navigate from Black Canyon to the point where they found these falls. The rapids on the Colorado River above Emery Falls made further upstream navigation impossible.

Salt River Project, Arizona

Salt River project.—Derived from Salt River, the principal source of water supply. Salt River (Rio Salada or Salinas) so named by the early Spanish explorers because of salty water added to the river from salt springs in the upper reaches of the river. The waters of the Salt River are relatively good waters in the main, averaging about 700 parts per million of solids.

Verde River.—The name of this secondary source of project water supply means green and was so applied by the early Spanish explorers because the river lined with plants and trees was in vivid contrast to the thousands of square miles of adjacent desert and treeless mountains.

Roosevelt Dam.—Named in honor of Theodore Roosevelt, who was President of the United States when the Reclamation Act was passed by Congress, and when construction of the dam was started. He dedicated the dam in 1911.

Horse Mesa Dam.—The name of this dam comes from a high plateau nearby the dam site which was a naturally fenced pasture where a rancher kept his saddle horses when not required for use. By blocking a small entrance there was no other place where the stock could emerge from the natural enclosure. The Horse Mesa plateau appears as a location on maps of the area.

Mormon Flat Dam.—A small valley called Mormon Flat is the main part of the reservoir created by the dam. Mormon Flat was named from the early Mormon emigrants who camped there and herded their stock on the abundant pasture.

Stewart Mountain Dam.—So named for Stewart Mountain nearby, the name "Stewart" being given in honor of Jack Stewart, who operated a cattle ranch in the vicinity and was the first white settler in that area.

Granite Reef Dam.—So called because of a reef of granite rock extending part way across the Salt River on which the dam is located for a part of its length.

Joint Head Dam.—This dam is a joint diversion point of two of the oldest canal companies of the Salt River Valley and thus obtains its name.

Bartlett Dam.—The dam site has been known by the name of the original locator of the dam site—William H. Bartlett, an engineer.

Cave Creek Dam.—Named from the creek or desert stream on which it is located for flood control purposes. The creek derives its name from the caves in the banks of the stream near its headwaters.

Intake Dam.—So called because it is located on Salt River at the head or intake of Roosevelt Reservoir and serves as a diversion dam for the power canal.

Arizona Canal.—This, the largest canal on the project, serves the north side unit. It derives its name from that of the State of Arizona, which is made up of two Pima Indian words, "Ari" and "zona," meaning "Place of Little Springs."

Grand Canal.—At the time of its construction the Grand Canal was the largest and longest canal in the Salt River Valley and was the fifth irrigation canal constructed. The word "Grande" is a common Spanish word and means large. The Grand Canal was the largest at the time, hence the name.

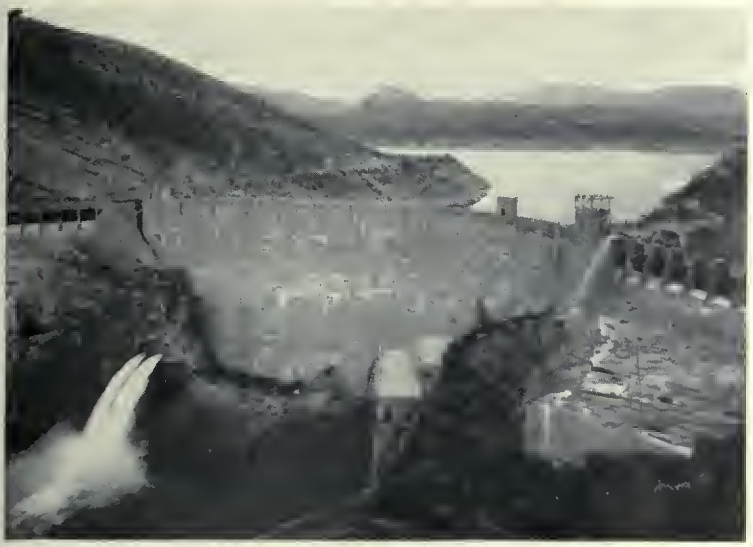
Maricopa Canal.—One of the oldest canals on the north side unit, named from a local tribe of Indians.

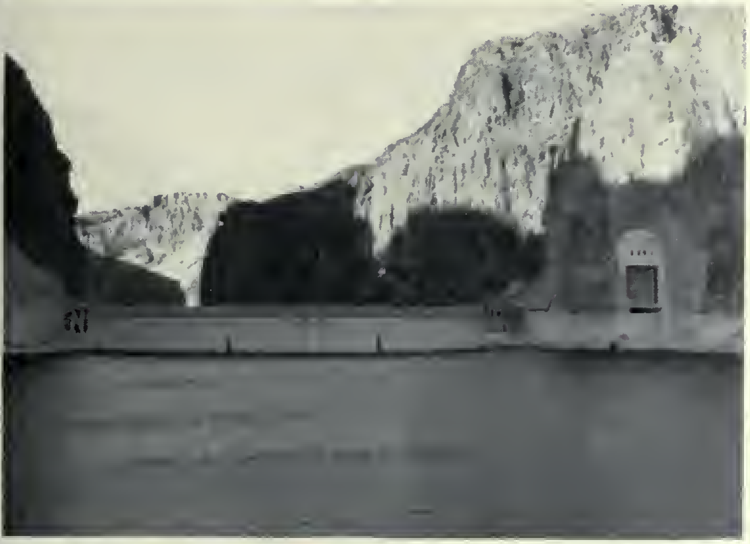
Consolidated Canal.—Named from the consolidation of several early canals.

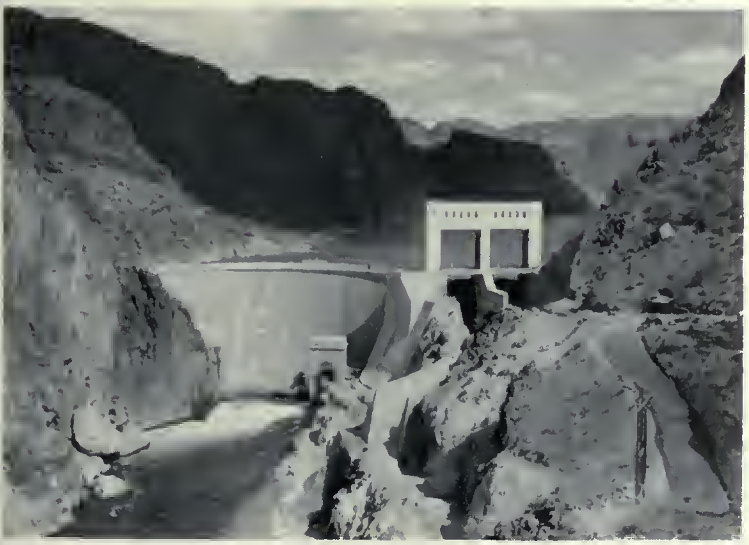
Mesa Canal.—Constructed and named by early settlers in and near the town of Mesa, which was named by the founders by virtue of its location on a table land above a small valley lying along Salt River to the south.

Tempe Canal.—Constructed and named by early settlers in and near the town of Tempe, which was located at the foot of a small butte on the banks of Salt River, and named after the Vale of Tempe in Thessaly.

San Francisco Canal.—The canal was constructed by white and Mexican settlers, using



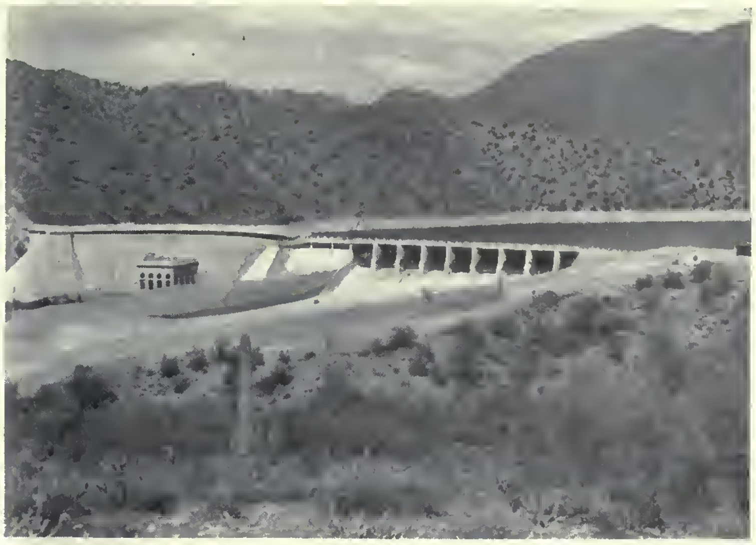


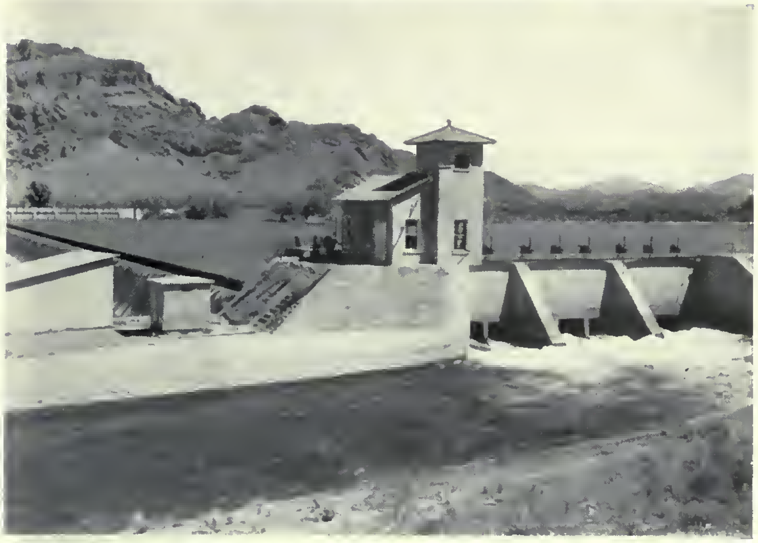


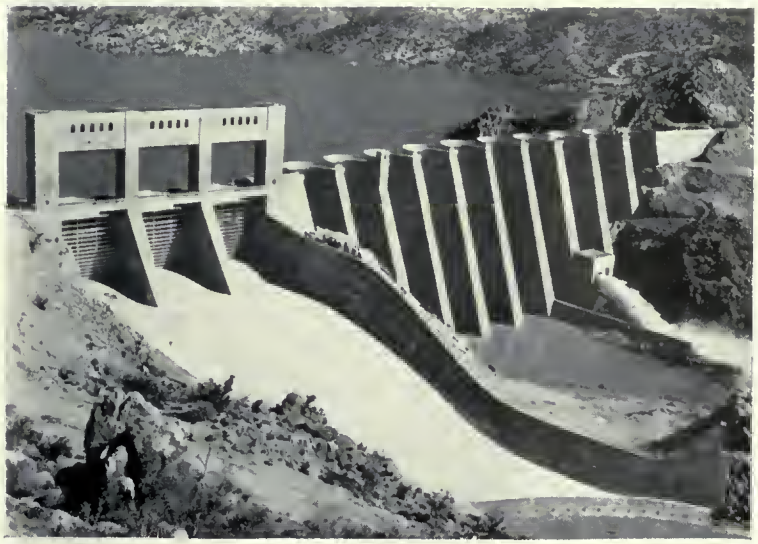
Top: Roosevelt Dam looking upstream.

Center: Horse Mesa Dam, from upstream side showing north and south gates, stairs to gatehouse, and gatehouse.

Bottom: Mormon Flat Dam, with two 50- by 50-foot steel regulating gates.



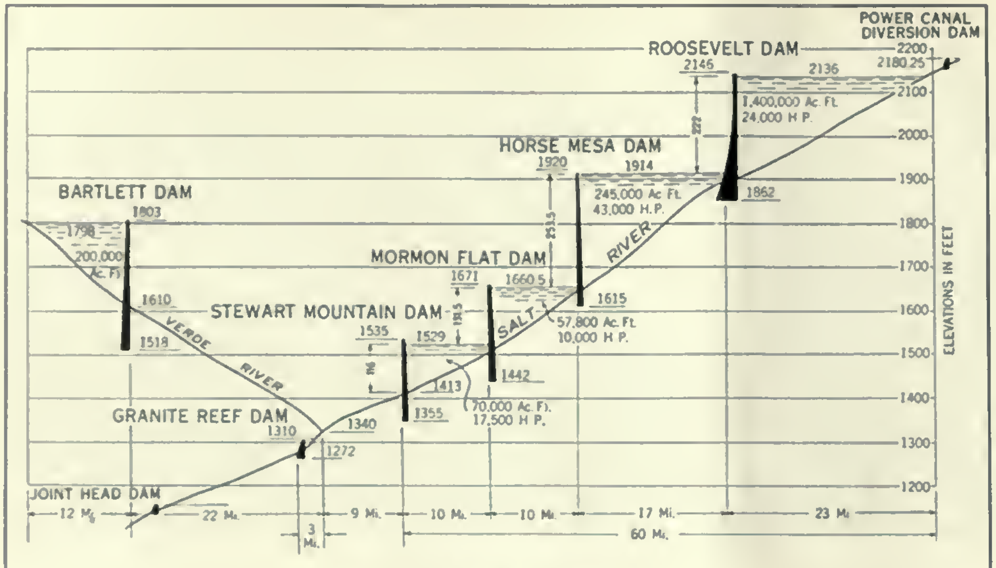




Top: Stewart Mountain Dam. Left abutment showing completed spillway channel.

Center: Granite Reef Dam.

Bottom: Bartlett Dam. The storage of 52,000 acre-feet did much to offset the short water situation on the Salt River project.



SALT RIVER PROJECT · ARIZONA

STORAGE WORKS
ON SALT AND VERDE RIVERS

CONSTRUCTED BY
BUREAU OF RECLAMATION

JULY 15, 1940

largely Mexican laborers for the work. The name originated from the patron saint of the Mexicans, St. Francis. The Mexicans were very devout Catholics and hoped by so naming the canal that it would always carry plenty of water to their lands.

Highline Canal.—So named because it is served by a booster pump from the Western Canal.

Phoenix.—The State capital was named by one of the early settlers from the fabled bird Phoenix that arose from its ashes. The town is located on the site of an ancient civilization, evidenced by old canals, building, etc.

Glendale.—The town was founded by Rev. B. A. Hatvel, of the Church of Brethren from Illinois, who bought 360 acres of land and founded the town. Why he called it Glendale is not disclosed by the archives of the State librarian's office.

Peoria.—The town of Peoria, Ariz., was founded by a settler named Greenhut, who came from the vicinity of Peoria, Ill.

Tolleson.—Named after the founder—W. G. Tolleson.

Cashion.—Named after the founder—James Cashion.

Scottsdale. Named after Winfield Scott, one of the early settlers in that vicinity.

Chandler.—Named after its founder—Dr. A. J. Chandler.

Gilbert.—So called after a man of that name who started the town on lands owned by him. He was a rancher and cattleman.

Laveen.—This town was started as a single country store on land owned by Roger Laveen, who is now the Maricopa County recorder.

Lehi.—The story behind Lehi comes from the Book of Mormon, which purports to be a history of the original people of the American continent. The Book of Mormon was written by Joseph Smith, the founder of the Mormon church, and, according to him, Lehi was the leader of a band of Israelites who started wandering 600 years B. C., and after 8 years landed in South America, where they became the first human inhabitants of the southern continent. To Mormons the name Lehi has a religious significance.

Grand Valley Project, Colorado

Colorado River.—The source of the water supply for the Grand Valley project is the Colorado River, so called because of its muddy appearance. At the time work on the project was started, the river now known as the "Colorado" was called the "Grand River," the Grand Valley being named after the river, and that name applied to the project.

In the year 1776 the river was named "San Rafael" by Father Escalante, and after his time apparently there was considerable confusion in the names applied to this stream. The Forest Service advises that above the junction of the Colorado and Gunnison Rivers, the Colorado was sometimes called the "Bunkara," the name probably being derived from the Ute title of Nah-un-ka-rea, and also that it was often called the "Blue River," the name "Blue" being restricted finally to the small branch in Summit County. In records back in 1812 we find the word "Grand" (meaning "large"), which apparently was applied to the river probably by trappers sometime prior to that date.

North Platte Project, Nebraska-Wyoming

North Platte River.—The Mallet Brothers, French explorers, gave this stream its name in the year 1739, and the name of the project followed that of the river which is its source of water supply. The Mallet Brothers were believed to have had Pawnee guides when they visited the river in the vicinity of Kearney. The Pawnee, and also the Omaha, Indian name for the stream, means "Flat Water," which is assumed to have been translated into the French "La Platte" or "Platte."

Pathfinder Dam.—Named for Gen. John C. Fremont, the "Pathfinder" of the West, who in 1842 journeyed up the North Platte River and through the canyon where the dam is located.

Guernsey Dam.—Named after the town of Guernsey and Hon. Chas. A. Guernsey, an early settler, cattleman, and developer of mining and other enterprises in the vicinity.

Fort Laramie Canal.—Named for Old Fort Laramie, which is located near the canal about 10 miles below the canal headgate, the name having come originally from a French trapper, La Ramie, who in the early fur-hunting times was there killed by the Arapahoes. Old Fort Laramie was a famous Army post on the Oregon Trail. This site has recently been made a national monument.

Whalen Dam.—Named for Richard Whalen, an early homestead settler at the site of the dam.

Interstate Canal.—So named because it is constructed in two States, Wyoming and Nebraska.

Mitchell.—This town was formerly the location of the project headquarters, and was named for Gen. Robert Mitchell. There was also a Fort Mitchell located near the river and a pass at Scottsbluff National Monument called Mitchell Pass.

Tucumcari Project, New Mexico

Tucumcari.—This name as applied to the mountain, the city, and the project is believed to have been originally "Tocom-Kari." A very interesting legend concerning its origin was told by Geronimo, an old Apache Indian now deceased, who lived at Fort Sill, Okla., and whose father had related the story to him.

Geronimo's father was at the mountain when Wautonomah, an old Indian chief, died. The chief, believing death near, had called two of his bravest young Indians to his cave and told them that as he would soon pass to the happy hunting ground, he would now settle the matter of his successor as chief of the tribe. These young braves were deadly enemies because both of them were in love with Kari, the beautiful daughter of Wautonomah. Each had asked for her hand. The names of the young braves were Tonopon and Tocom. Kari, who loved Tocom and hated

Tonopon, was hidden in one of the rooms of the cave when her father sent for the two young men and heard the proposition made by the chief.

Wautonomah said, "I know you both love Kari. Both love your chief. Both are brave. Wautonomah loves the White Flower (meaning Kari). Tonight at midnight go down from the mountain and upon the plain meet alone. Each shall have a dagger. There settle this matter, and the one that lives and comes to my cave with the blood from his assailant upon his dagger shall be my successor and shall have Kari for his squaw."

The young braves did not look at each other but quietly left the cave. A little later Kari slipped from the cave and went unseen to the plain where she could see the combatants. At the appointed time two dark figures could be seen approaching the battle ground, and the heart of Kari beat fast. When they closed in, each gave a hideous yell, plunged at the other, and grappled the hand of his assailant that held the dagger. For a few moments there was wrestling and writhing, and then the hand of Tonopon descended, and his dagger reached the heart of Tocom. Tocom sank to the earth, the blood gushing from his breast, and as Tonopon stopped to catch Tocom's blood upon his dagger, a form rushed from the bushes, leaped upon him with a scream, and drove her knife into his heart. He fell to the ground dying. After the girl was satisfied that her enemy and the murderer of her love was dead, she lay down with her head on the bosom of Tocom and with the knife with which she had just killed Tonopon, took her own life.

As neither of the men arrived at the cave that night, Wautonomah sent one of his men to the plain the next morning, and when they found the bodies of the three, bore them to the cave. When they told their chief they had found the bodies of the two young braves and Kari with her head on the breast of Tocom, the old chief cried, "Tocom-Kari, Tocom-Kari," and, taking the dagger with which his daughter had taken her life, plunged it into his own breast, crying, "Tocom-Kari." This was the last word spoken by Wautonomah, and that name was given to the mountain. The name has been somewhat changed, and is now pronounced Tucumcari.

Tucumcari is a thriving little city of 6,200 population about 2 miles from the foot of Tucumcari Mountain and is the only town within the Tucumcari project.

Conchas Creek, Conchas Dam, and Conchas Canal.—The name "Conchas" appears to have been suggested by the presence of the conch shell, a large trumpetlike shell. There are conflicting stories that the name may have originated either from the early Spanish or Indian inhabitants of the region. The Spanish were inclined to decorate their saddles and personal trappings with ornaments and the cinch buckle was also called a concha. At any rate the dam and canal were named primarily because Conchas Creek is a principal tributary of the South Canadian River and the junction is immediately above Conchas Dam.

Pajarito Creek.—There are many creeks and arroyos named by the Spanish on this project, and perhaps the most costly siphon on the Conchas Canal crosses under the Pajarito Creek, which name means "a small bluebird."

Pine River Project, Colorado

Pine River.—The river was named "Los Pinas" ("the pines") by early Spanish explorers. It is assumed that the river was so named because from Bayfield to the headwaters of the river the valleys and mountains are covered with pine trees. The project is situated in La Plata County, Colo., which is a part of the San Juan Basin, one of the oldest inhabited sections of the State. This basin was originally the home of the cliff dwellers, and later of the modern Ute Indians.

The first white men known to have visited this area were Spanish monks seeking a route from the presidio of Santa Fe, N. Mex., to the missions at Monterey, Calif. One of these early expeditions was led by Fray Francisco Atanasio Dominguez and Fray Silvestre Velez De Escalante, who started from Santa Fe on July 29, 1776. A copy of the journal describing this journey has been found, as well as a copy of the original map drawn by Escalante, of the country traversed at the

(*Continued on p. 263*)

Upper: Looking downstream at Vellecito Dam.
Lower: Looking toward left abutment from right side of temporary diversion channel. Placing compacted embankment in diversion channel in right foreground. Temporary cofferdam in left foreground.

Defense Resources Committee Appointed

SECRETARY of the Interior Harold L. Ickes appointed a Defense Resources Committee within the Department of the Interior to coordinate Department efforts and to cut through any routine procedural difficulties in order to expedite the defense program. He ordered his staff and the committee to insure immediate right-of-way for all activities involving national defense and to assist any agency of the Government that the President has designated or may authorize to develop any phase of defense.

In his letter to First Assistant Secretary E. K. Burlew, Secretary Ickes designated him as chairman and announced membership of Department officials as follows:

For mineral and oil resources: Dr. W. C. Mendenhall, Director, Geological Survey.

For mineral production, metallurgy, gas and antigas devices, explosives, helium and related subjects: Dr. R. R. Sayers, Director, Bureau of Mines.

For oil supply, production and handling: George Holland, Director, Petroleum Conservation Division.

For grazing resources and cattle production: R. H. Rutledge, Director, Grazing Service.

For power production: John C. Page, Commissioner of Reclamation.

For power policy and administration of minerals on public lands: Joel D. Wolfsohn, Assistant to the Commissioner of the General Land Office.

For forestry resources under the Department on public lands, parks, Alaska, etc.: Lee Muck, Director of Forests.

Secretary: Walton Onslow, Division of Information.

Secretary Ickes further stated: "The function of the Defense Resources Committee will be to implement the Department's efforts in the defense program and to act as a clearing house for all defense activities. Contact with the Department on defense matters will be made through this committee, which will see that no authorized agency fails to receive the full benefits of the Department's assistance because of lack of knowledge of the aid available. It shall cooperate with the National Defense Advisory Commission to fix responsibilities and avoid inaccuracies and misinterpretations of subject matter, requests for assistance or information and the responses to such inquiries from authorized sources should be transmitted in writing.

"Our Nation faces a difficult task. This Department possesses the tools and knowledge to deal with important aspects of national defense.

"This Department must bear its full share of the burden the national defense program puts on all of us. To see that this is accomplished the Defense Resources Committee is herewith established."

Combining Water Users Activities Humboldt Project, Nevada

By F. M. SPENCER, *Acting Construction Engineer*

THE Humboldt River originates in the northeastern corner of the State of Nevada and flows, without any great amount of fall throughout the various sections of its course, westerly and southerly to the Humboldt Sink in the west central part of the State. Little water has reached the Sink during later years, except drainage water from nearby irrigated lands, as there has seldom been a sufficient run-off to meet all irrigation requirements along the stream. Throughout the first half of its course there are numerous small tributaries which deliver to the main stream such flows as become available from snow accumulations in the adjoining higher areas. The last half of the river follows an exceptionally flat valley floor, meanders considerably, and has only one so-called tributary, the Little Humboldt River. There is some doubt concerning the propriety of designating the last side stream as a tributary because, in flowing through a small fertile valley, it is overburdened with irrigation requirements of its own, and for about 17 years there has been no appreciable contribution to the Humboldt River from that source.

As a whole, the region drained by the Humboldt River and its tributaries is classed as semiarid and must depend almost entirely for its irrigation water on winter snowfalls and accompanying snow accumulations at the higher elevations of the watershed. On this account particularly, storage facilities which permit the regulation of stream flows and the retention of available water for carry-over purposes are exceptionally important.

By general natural conditions, such as drainage basin topography, differences in climatic effects, and the comparatively long river water transit time, there is a rather distinct division between the upper and lower portions of the Humboldt River valley. That division has been emphasized by irrigation developments which have created increasing demands on the available water, by various legal actions, and by other artificial causes, and there have been many serious controversies between the upper and lower valley water users. By the creation of the Humboldt project, construction of Rye Patch Dam, and the purchase and transfer of certain water rights from the middle section to the lower section of the stream system, much headway was made toward the elimination of many of the controversies which concerned water users.

Except for the above-mentioned purchase and transfer of water rights and some channel and drainage improvement work along the middle section of the river, the Humboldt project was exclusively a lower valley development. This project includes the lands of the Pershing County Water Conservation District, which are adjacent to Lovelock, Nev., and provided for the construction of the Rye Patch Dam on the Humboldt River about 24 miles upstream from the town of Lovelock. The dam created a reservoir with a maximum capacity of 179,070 acre-feet, thus making possible the regulation and storage of water for use on district lands below.

No distribution system construction was included in the Humboldt project program as such facilities had been built many years previously by groups of private interests for diversions from the river into which Rye Patch Reservoir releases are made. In addition to the existing project distribution system, which was to be directly served by constructed works, there had existed for several years prior to the formation of the Humboldt project, two privately constructed reservoirs and their distribution system. Those two reservoirs, known as the Humboldt Lovelock Irrigation Light & Power Co. reservoirs, are located immediately adjacent to the Rye Patch Reservoir and are filled from the Humboldt River by a feeder canal. Their action is joint so that the two reservoirs, in practically all effects, are the same as if they were combined into one. Lands in the upper part of the area adjacent to Lovelock, known as the Lovelock Valley, which were not included in the Pershing County Water Conservation District, are served from the two old reservoirs; and thus there has been a division of interests in the local area very similar to the division of interests on the stream system as a whole.

The Lovelock Valley, being on the lower end of the Humboldt River, was a fertile field for controversies which resulted from the local division of interests. Those controversies, at times, assumed enormous proportions in the minds of people who, living in the same localized area, should have been, in harmony, actively working for the development of one of the most productive valleys in the Western States. Only those who have come into direct contact with such controversial situations can fully realize the bitterness and trouble that can develop over matters involving the use of irrigation water, particularly where water is not plentiful and stream flows are erratic.

Rye Patch Dam construction work began January 31, 1935, and, although some storage of water was possible by the following September 23, construction was not finally completed until September 25, 1938. Water right controversies had been in evidence very much earlier than even the investigations and preliminary reports which preceded the beginning of Humboldt project construction, but legal action was not resorted to in large scale proportions until after definite project activities were commenced. In the annual project report, which was forwarded shortly after the close of the year 1938, there were reported 10 separate cases or lawsuits which had a direct bearing on water rights on which the construction of Rye Patch Dam was founded.

The pending litigation has been not only a detriment to project success, but an expensive hindrance to the economic, social, and agricultural progress of the entire valley. Its existence, in its effect upon outside interests, has been a very deciding factor in preventing the subdivision of district lands, settlement, and general development.

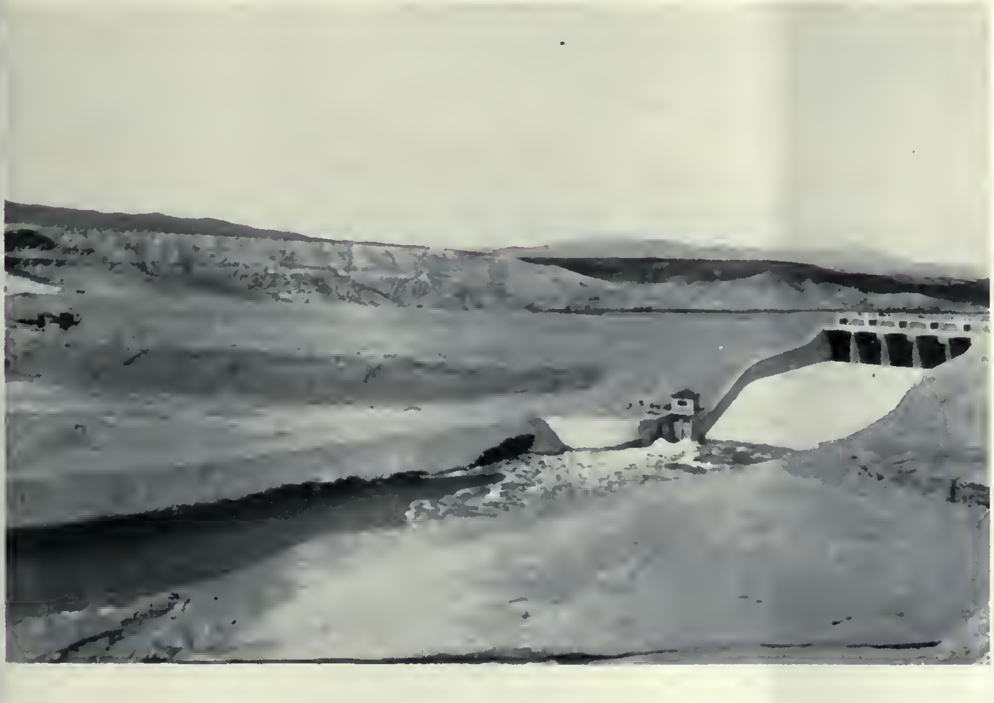
For several years there have been almost constant efforts made to obtain the settlement of controversies in Lovelock Valley, either by a unification of rights, facilities, and development activities, or by a special agreement for the termination of pending litigation and adjustment of controversial matters.

This goal has finally been reached by the execution of an extensive and far reaching agreement, sometimes called the Treaty and Compact. Parties to this agreement consist of the United States of America, The Pershing County Water Conservation District, Humboldt Lovelock Irrigation Light & Power Co., three separate ditch companies, and two individuals, including the Nevada State Engineer. Of perhaps most importance, the agreement provides for the dismissal of all pending actions at law and suits in equity, and for adjustments and understandings in regard to water rights, storage, and distribution.

By the execution of the agreement, Lovelock Valley now enters a new era of progress and development. Records show that, with Rye Patch Reservoir in operation under these new arrangements, there will seldom be a shortage of irrigation water. It is known that the lands to be irrigated are among the most fertile of the Western States. Climatic conditions, transportation facilities, and other advantages are decidedly in favor of rapid development. That valley should now become one of the most desirable for permanent home locations.

Part of a 450-acre field of sugar beets, Humboldt project

Rye Patch Dam, Humboldt project, Nevada



Visit Boulder Dam

NOW is the time to become acquainted with your own country, to get first-hand knowledge of its beauty and of its great natural resources. Among its chief attractions is Boulder Dam on the Arizona-Nevada border, to which tourists in ever-increasing numbers journey each year, more than 600,000 being this year's estimate.

Boulder, the highest dam, has the largest hydroelectric power plant and the biggest man-made lake in the world. The power plant, with about half of its great generators in action, is of particular interest. The batteries of these generators, two stories high, are lined up in the two wings of the U-shaped powerhouse, two city blocks long and as high as a 20-story building.

Regular quarter-hour trips are made down the elevators from the top of the 726-foot dam to the power plant at its base, a charge of 25 cents per person being made for adults, children free.

Lake Mead, the tremendous reservoir created by damming the river, stretches 115 miles upstream to the western entrance of the Grand Canyon.

The recreational area of the lake, under the supervision of the National Park Service, provides boating, swimming, and fishing. The lake is a fisherman's paradise, especially famous for its large-mouth bass.

Boulder Dam is easily accessible by motor, rail, and airplane. Adequate hotel, auto camp, and tourist accommodations are available in Boulder City, Las Vegas, and Kingman.

CONCRETE FOR SHASTA

Model of Rye Patch Dam Wins Recognition

By ROBERT S. LEIGHTON, *Instrumentman*

IN connection with the celebration and air show held July 4 on the Humboldt project at Lovelock, Nev., a parade was staged to start the activities. The parade was open to all float entries, and the prize-winning float was a model of Rye Patch Dam constructed by F. M. Preston, gatetender at the dam.

Late in June Mr. Preston conceived the idea of building a miniature model of Rye Patch Dam on the flat bed of a 1½-ton truck for entry in the parade. The dam furnished excellent material for a float theme as it is of vital interest to people in this community, but the amount of painstaking labor and time required was considerably more than was anticipated when the idea originated. The original plan was to build the dam and abutments of a mixture of sand and clay in such proportions as to give the greatest stability, and to construct the spillway and buildings of heavy cardboard, all in detail on a scale of about 1 to 50.

The dam is an earth and rock-fill structure, standing 68 feet above the Humboldt River channel, with a length of 914 feet, including the spillway in the west abutment. The crest width is 30 feet. The spillway is a concrete structure, 110 feet wide, with five 20-by-17-feet radial gates. There are five buildings near the dam which serve as control house, gatetender's home, shop, garage and storehouse, and gasoline storehouse.

The first step in preparing the model was to place 6-inch sideboards on the flat bed truck and to load it with a mixture of sand and clay, moistening the mixture so that molding, to represent the topography near the dam, could be accomplished. Immediately it was found that sufficient earth material with the proper moisture content to do this accurately would overload the 1½-ton truck; consequently, empty wooden boxes and tin cans were placed in the proper places to form the bulk of the higher surface elevations, and the clay mixture was molded over them. The miniature dam was built entirely of sand and clay, with large-sized gravel being used to form the downstream rock fill and the upstream riprap blanket. It was necessary to take extreme care in compacting and molding this earth work as it had to stand the vibrations of the moving truck, without crumbling or cracking, throughout a 25-mile trip from the dam to Lovelock, as well as a 2-mile run in the parade.

The spillway structure parts, which included walls, floor, bridge deck, operating deck, piers and radial gates, were all cut from heavy cardboard. These parts were necessarily cut to provide flanges and overlapping pieces to facilitate fastening together as a unit. After much time had been spent on this cardboard construction, it was abandoned because the spillway walls, especially the inlet and outlet transitions, would not remain true to line or grade. Finally, the spillway walls, floor and bridge abutments were made of concrete. A sand-cement mixture of 1:3 was used. The cardboard walls were used as a front form while the sand-clay abutments were molded to serve as a back form. Two small pipes were placed in the concrete at the tunnel outlet, to represent the two 48-inch pipes which discharge reservoir water into the stilling basin.

Construction Details Shown in Model

The bridge deck, operating deck, piers and radial gates, previously made of cardboard, were used and anchored in the concrete with wire. These parts were then painted with cement grout to give the appearance of concrete construction. The piers, bridge decks, and radial gates were made accurate to the smallest detail. The noses of the piers, handrail posts, and arches beneath the decks were carefully simulated.

All of the buildings were built of cardboard and painted brown with white trim, except the control house which was painted with cement grout. Windows of the buildings were made of clear cellophane, and doors and window trim were painted. The buildings were placed, with respect to the model dam, to imitate actual conditions; and a small flagpole, with flag flying, and miniature trees, were located appropriately in the yard.

Bunting and flags were used to decorate the truck and signs were placed to read as follows: (front) Rye Patch Dam—Heading for Prosperity; (rear) Rye Patch Dam—Conserves Lovelock Valley Water Supply; (side) Rye Patch Dam—Makes the Humboldt River Dependable; (side) Rye Patch Dam—Capacity 179,070 acre-feet.

Mr. Preston spent approximately 60 hours of his own time from June 20 to July 4 in building this model, and it certainly deserved the first prize award; but the favorable comment received from the community and the publicity given the Humboldt project by this means were the finest results of the work. Mr. Preston has now been made a member of the Pershing County committee to build the county exhibit at the State fair to be held in Fallon, Nev., in September; naturally, his model dam will be a principal part of the exhibit.

Rye Patch Dam

Honorary Degrees Conferred on Reclamation Officials

S. O. Harper

SINCLAIR O. HARPER, Chief Engineer of the Bureau of Reclamation, was awarded the honorary degree of Doctor of Science on June 10, 1940, at the annual commencement of the University of Colorado, in recognition of his long service with the Bureau in the development of the water resources of Colorado and the other Western States.

Upon his graduation from the University of California in 1907 with the degree of Bachelor of Science in Civil Engineering, Mr. Harper entered the Reclamation Service as junior engineer on the Uncompahgre project in Colorado. His ability was quickly recognized, and in 1908 he was assigned to the newly adopted Grand Valley project, where he was placed in charge of topographic and location surveys and the preparation of plans and estimates. From 1912 to 1917 he served as construction engineer on important features of the project.

Left: K. B. Keener; *right:* S. O. Harper

In 1917 Mr. Harper was placed in charge of the Grand Valley project. He managed the project for 8 years, during which period he worked out plans for the rehabilitation of the old irrigation districts in the valley and directed the reconstruction of their irrigation systems, which, together with the construction of much needed drainage works, established the basis for a sound agricultural economy in the valley.

In 1925 he was appointed General Superintendent of Construction for the Bureau, and in 1930 was made Assistant Chief Engineer. In these capacities, as one of the principal executive officers of the Bureau, he took a leading part in directing construction and operation of more than 40 reclamation projects in the Western States, including Boulder Dam, Grand Coulee Dam, the Central Valley project in California, and the All-American Canal, and in building up the central engineering office in Denver to recognition as the foremost organization of its kind in the world.

From 1935 to 1939 Mr. Harper served as chairman and representative of the United States on the Rio Grande Compact Commission, which consummated a history-making agreement for division of the waters of the Rio Grande among Colorado, New Mexico, and Texas, terminating many years of controversy and litigation.

Mr. Harper is a member of the American Society of Civil Engineers, the Colorado Society of Engineers, and the Phi Kappa Sigma fraternity.

K. B. Keener

THIRTY years after receiving his Bachelor of Science Degree from Ohio Wesleyan University, Kenneth Bixby Keener was awarded an honorary degree of Doctor of Science on June 10, 1940, at the annual commencement of Ohio Wesleyan University.

Entering the service of the Bureau shortly after his graduation, August 19, 1910, Mr. Keener's services have been almost continuous since that date. Until September 1926, his headquarters were maintained at various points on the Boise project, Idaho, which was then in an active state of construction. His initial assignment was as chairman on canal location and he served successively, as rodman, computer, timekeeper, costkeeper, instrumentman, and chief of party until July 1, 1916, when he was appointed a junior engineer, and thereafter was given positions of increasing responsibility. He was field engineer on the construction of Black Canyon Dam, one of the principal features of the Boise project, and later he was appointed resident engineer on the construction of the Black Canyon power plant.

Upon his transfer to the Denver office in 1926, he was intermittently assigned to design work and the preparation of supply and construction contract specifications. In October 1930, when contract designs for Boulder Dam were started, he was made principal assistant to B. W. Steele, engineer in charge of the division of dams. Upon the latter's resignation in May of 1936, Mr. Keener was appointed to fill this position, and he has served continuously in that capacity to the present date.

Mr. Keener's membership in professional societies includes the American Society of Civil Engineers, the Chi Epsilon honorary engineering fraternity, the Teknik Club, and the American Concrete Institute. In addition to the degrees of Bachelor of Science and Doctor of Science which he has obtained from Ohio Wesleyan University, Mr. Keener also holds a Bachelor of Science degree in Civil Engineering from the University of Colorado.

In recognition of his outstanding ability and technical knowledge of the design of large storage dams, Mr. Keener was made chairman of the American National Committee of the International Commission on Large Dams of the World Power Conference, and attended the meetings of this conference at Vienna, Austria, during the late summer of 1938 as an official representative of the United States Government.

F. A. Banks

FRANK ARTHUR BANKS was awarded an honorary degree of Doctor of Engineering on June 10 at the sixty-ninth annual commencement of the University of Maine, his alma mater.

The citation which accompanied the degree, conferred by President Arthur A. Hauck, was:

"Graduate of the University of Maine in the class of 1906; eminent engineer, able and admired administrator; early finding a professional career with the Bureau of Reclamation of the United States; rising steadily to positions of great responsibility; now the Supervising Engineer of the Grand Coulee Dam in Washington, the largest engineering and construction project of its kind ever undertaken.

"Your distinguished record has brought honor to your alma mater. With pride and gratitude we confer upon you the degree of Doctor of Engineering."

Left: **President Arthur A. Hanch, University of Maine**

Right: Frank A. Banks

A native of Saco, Maine, he entered the university where he was elected to Phi Kappa Phi, general scholastic society, and was editor of the junior class yearbook, president of the athletic association, and a class officer, graduating in 1906.

Since his graduation he has been connected with the Federal Bureau of Reclamation. He was in charge of construction of many large reclamation dams of the West, including the Owyhee and American Falls Dams in Oregon and Idaho. In 1933 he was assigned to the Grand Coulee Dam in central Washington, which will be three times larger than any other man-made structure, one of the largest construction jobs ever handed an engineer. In 1937 he was appointed to the advisory committee for the administration of the associated project at Bonneville.

Mr. Banks' preparation for his present position included experience on a number of record and near-record construction projects. His first assignment in a supervisory capacity, in 1919 at the Jackson Lake enlargement in Wyoming, was a good start as the reservoir was the fourth largest in the United States and fifth in the world. In 1932, on the Owyhee Dam he completed what was then the world's highest dam, parts of the foundation of which had to be laid in an excavation 250 feet below low-water level. On that job was worked out apparatus to cool concrete, an experiment which aided materially in the planning and design for Boulder and Grand Coulee Dams.

Change in Hours Interior Department

Effective Monday, September 16, the Interior Department, with the exception of the Fish and Wildlife Service, will resume the 9 o'clock opening schedule, thus making the closing hour 4.30 p. m., by order of Secretary Ickes.

During the summer months the Department hours were from 8 to 3.30.

Origin of Names

(Continued from p. 257)

Aztec Ruins National Monument, Aztec, N. Mex.

San Juan, the Piedra, Los Pinos, Florida, and Las Animas Rivers.—Although Escalante is credited with making the first map of this area, and by some with naming the rivers, a perusal of the diary kept on this Dominguez-Escalante Expedition leads us to believe that the rivers in this area had been named by earlier Spanish explorers. The diary mentions that earlier parties had been sent to the La Plata Mountains to examine reportedly rich mines, and also that Don Juan Maria De Revera had journeyed through this country in 1761.

Vallecito.—Diligent search has revealed no information concerning the date or the person who named the Vallecito. In Spanish the name means "Little Valley," but other than the fact that it is descriptive of the valley, no information as to its origin has been found. The dam was named for the valley.

Durango.—This town was founded in 1880 and became the terminus of the Denver and Rio Grande narrow-gage railroad from Alamosa, Colo., which was completed in August 1881. It is said that Durango was named for Durango, Mexico.

Bayfield.—The present town of Bayfield was started with the building of a store in 1886, and at that time was called "Los Pinos." In July 1898, William A. Bay surveyed and filed on a town site at this place and named it Bayfield. Mr. Bay is still living and was a recent visitor to the project.

Ignacio.—This town is now the headquarters of the Southern Ute Indian Reservation. Named for the famous Chief Ignacio of the Southern Ute tribe, it did not become a town until after 1899, and was laid out as such and filed for recording September 18, 1909.

Allison.—Named for Allison Stocker, who was one of the builders of the Pine River Canal.

Tiffany.—Named for J. E. Tiffany, who settled there in 1902.

Falfa.—So named because of the vast acreage of alfalfa surrounding it.

Construction of Spring City Tunnel

SANPETE PROJECT, UTAH

By **M. S. ROSS**, *Associate Engineer*

COMPLETION of the Spring City tunnel marks the finish of the present construction program of the Sanpete reclamation project, Utah. The tunnel, second unit of the project, is similar in purpose to the Ephraim tunnel completed in 1937. Water is diverted from Cottonwood Creek, a tributary of the Green River, through the Ephraim tunnel for irrigation of 6,750 acres in the Ephraim division, while the Spring City tunnel diverts water for the Spring City division. As originally planned, the project included a third unit, the Gooseberry Reservoir and tunnel, which were excluded from the present program owing to the high unit cost of water to be delivered.

The tunnel is located in central Utah on the divide between the Colorado River Basin and the Great Basin in the Wasatch Mountain range about 12 miles from Spring City. This town is the nearest railroad point and access to the tunnel is made over a steep, unimproved mountain road which made transportation of materials and supplies a major problem.

Supplementary water is made available by the tunnel for some 6,000 acres of rich irrigated lands located in the Sanpete Valley at an elevation of 5,000 feet where the growing season is relatively short and feeds for livestock are the main crops.

Owing to steep grades in the mountain streams no storage reservoir sites are practical for development. Therefore, irrigation of crops is mostly done when the streams are swollen from melting snow which is retained in the high mountains until early summer. Two short feeder canals collect water from streams fed by springs and deep snow banks on the eastern or Colorado River slope of the mountain range. This water is diverted through the tunnel at an elevation of 9,800 feet above sea level to the western slope of the mountains where it flows down a natural creek channel to farms of the Horseshoe Irrigation Co. in the Spring City division in the valley below. Prevailing westerly winds transport snow from the western slopes near the summit to build up deep drifts on the east side of the mountain top. The development of trans-mountain diversions in this section of the country was partly due to this condition, which as a natural reservoir is augmented by the fact that the run-off on the eastern slopes occurs about 2 weeks later than on the west side. Although the drainage area which furnishes the supplemental water is relatively small, compared with the prime area on the western slopes, the supplementary supply is very good, being a large portion of the water now used.

Construction Features

The Spring City tunnel is a concrete-lined horseshoe section 5,000 feet long and 5½ feet in diameter. The inlet portal is provided with a 20-foot concrete transition, and at the outlet portal a 50-foot reinforced concrete chute provides a conveyance for the water from the tunnel to a natural stream bed.

The feeder canals are about 2 miles long, 8 feet wide, and have a combined capacity of 100 second-feet. The canal diversion structures, a wasteway and roadway bridge are all constructed of log cribbing. CCC forces were employed to construct the canals.

Principal quantities involved in the tunnel and canal construction are:

Excavation in open cut	cubic yards	1,300
Excavation in tunnel	do	6,500
Permanent timbering with steel supports	linear feet	687
6-inch diameter tunnel drain	do	2,130
Concrete in tunnel lining	cubic yards	1,820
Concrete in portal structures	do	30
Excavation in canals	do	25,000
Log cribbing in canal structures	M. ft. b. m.	40

Competitive bids for construction of the tunnel were opened on September 21, 1937, and a contract was subsequently awarded to Dan Teters and Co., Inc., of Riverside, Calif., the low bidder on a bid of $128,235. Construction of the canals, placing of part of the tunnel lining, and hauling of cement and concrete aggregates, which were furnished by the Government, were performed by Government and CCC forces.

Transportation Problems

Upon award of the contract in October 1937, the contractor started construction of a short road necessary to connect the Forest Service road with the outlet portal, site of the construction camp. Building of the camp and work preliminary to "getting underground" were executed during the first few weeks of winter.

Most equipment and large supplies of fuel oil, blasting powder, and other material were hauled to the site of the work before the roads were made impassable to trucks by the winter snows.

Because of the high elevation of the tunnel, the winters there are long and severe, and the average maximum depth of snow is 6 to 8 feet. As the work was continued through the winter, frequent trips to town by horse-drawn bobsleigh were necessary to obtain repair parts and miscellaneous supplies. The sleigh road was kept passable by daily travel which kept the snow packed hard.

Before spring came, in June, it was necessary to replenish, by sleigh transportation, exhausted supplies of fuel oil, coal, gasoline, and blasting powder.

During the following summer about 5,900 tons of sand and gravel aggregates and 4,600 barrels of cement were hauled up the steep, winding road to the tunnel by CCC-operated trucks. The sand and gravel were shipped by rail to Spring City from a pit 100 miles north of the work.

Tunnel Excavation

The heading was started at the outlet portal on November 11, 1937, and owing to unexpected slow progress, drilling was not started at the inlet portal until June 17, 1938. The tunnel was holed through on September 13, 1938.

Material encountered was mostly a limey shale laid in nearly horizontal, relatively thin strata. Some thin beds of competent limestone were interlaid with the shale but were of insufficient quantity to offer structural support.

Little water was developed, but along reaches of the tunnel where it did enter, sloughing of the shale occurred. For a distance of 686 feet, where sloughing was the greatest, 2-inch timber lagging, supported by structural steel ribs, was installed. Sloughing occurred to some extent several weeks after the ground was excavated in about 25 percent of the tunnel distance. Total overbreakage, including sloughing, amounted to 17.4 percent.

Considerable difficulty was experienced at times by artificial detonation of the powder charge. Open cross seams in the rock caused all holes to fire simultaneously, resulting in the powder blowing out of the holes and not breaking any rock.

Equipment used in the heading consisted of two Ingersol-Rand DA-55 auto-feed drifters, mounted on arms attached to a vertical bar. Detachable bits were used in the drills for some time but these were replaced with location sharpened steel on account of frequent breakage of the bits. A Gardner-Denver mucking machine was used to load ½-cubic yard mine cars. Switching was done by hand over a California type "jump switch." The cars were drawn over an 18-inch gage track by means of a Mancha electric locomotive.

On account of the incompetency of the rock, the track was continually settling on long sections of the line where the invert became a "mud hole." This condition was a cause for considerable track maintenance and minor delays caused by derailment of the muck train.

Ventilation was obtained by means of a Root-Connersville blower coupled to a 15-inch diameter rubberized canvas ventilating line. Because of the crowded working conditions in the small bore, the ventilating line was frequently ripped open by passing cars, and before the job was finished 1,500 linear feet of the rubberized canvas line was replaced with 12-inch diameter galvanized metal pipe.

Compressed air for drilling was supplied through a 4-inch diameter pipe line by a 460-cubic feet per minute Sullivan Compressor. It was driven by a Caterpillar D 13000 Diesel motor.

Other outside equipment consisted of a pneumatic drill sharpener, an Ingersol-Rand bit grinder, two 5-kilowatt gasoline motor-driven generators used for charging the batteries and supplying power for tunnel and camp lights, three storage tanks, and miscellaneous small equipment.

Operations from the inlet portal were prosecuted on a smaller scale. A 315-cubic feet per minute Sullivan compressor was used to drive one drifter; mucking was done by hand and muck cars were trammed with a horse. Eighteen percent of the length of the tunnel, or 882 feet, was driven from the inlet portal.

Tunnel Drain

In order to simplify concreting operations, 6-inch drain tile, embedded in gravel, was laid for a distance of 2,100 feet from the outlet portal. The drain gathered most of the water developed, which was mainly concentrated near the upper end of the tile. In another wet section of the tunnel, an additional 50 feet of drain was installed. The water collected was pumped out of the invert while concrete was placed.

Concrete Lining

The unlined diameter of the tunnel was 6½ feet, making the nominal thickness of concrete equal to 6 inches. However, overbreakage caused the lining to be as thick as 3 feet in a few places.

Aggregates were stock piled on the hillside above the batching plant by the use of log cribbing on the downhill side to retain the piles. Rectangular metal chutes were employed to convey the aggregates to the batching plant. Oil flames were confined along the bottom of the chutes to heat the sand and gravel.

Weighing of aggregates was done on a manually operated Johnson beam scale weigh batcher. One-sack batches were loaded into mine cars and the cement added at this point.

Mixing was done at the point of placement. The mixer, an old model 7S Boss, was remodeled and powered with an air motor to permit its use inside the tunnel. It was charged from mine cars and emptied into a location-made pneumatic gun coupled to it. The whole assembly was mounted on flanged wheels which ran on the 18-inch gage track in the tunnel.

The sides and arch, constructed before the invert, were placed continuously except for mechanical failures and delays when time was taken to remove "tight" points from the tunnel walls.

The forms were constructed of metal-lined wood panels. The lower panels were set on 6- by 6-inch longitudinal sills set to line and grade and securely blocked and braced. As concrete placement progressed the panels were inserted to form the sides and arch. All of the arch and sides, and about 1,400 linear feet of invert, were spaced when shortage of aggregate necessitated suspension of concrete operations.

Concrete placement started on September 9, 1938, and was discontinued on February 10, 1939. Average daily progress was 70 linear feet, or 19.7 cubic yards, when placing the sides and arch and 280 linear feet, or 22.4 cubic yards, for the invert in a 24-hour day.

An order for change was negotiated with the contractor when it was deemed impractical to haul concrete aggregates during the winter and the contract was terminated.

Reclamation field office and residence, Spring City Tunnel

Excavation of Cedar Creek Feeder Canal, tributary to Spring City Tunnel

Government Force Work

During July and August of 1939 the remainder of the invert was placed by Government forces.

A reinforced concrete chute 4½ feet wide, 6 to 4 feet deep, and 50 feet long, was constructed before work was resumed in the tunnel. Placement of the invert was delayed in order to allow the flow of water, developed in the tunnel, to reduce.

Unwatering in the tunnel consisted of flushing the drain tile, installed by the contractor, which had become clogged with silt, and the preparation of collecting sumps in the tunnel invert. Water was pumped from the sumps through a 1½-inch pipe line suspended from the side of the tunnel.

Batching and mixing were done outside and the concrete transported into the tunnel in mine cars. Screeding and finishing were done by hand methods. The remaining 3,500 feet of invert was placed in 10 days, making an average progress of 350 linear feet, or about 28 cubic yards per 8-hour shift.

Under terms of the order for change which terminated the contract, the contractor's camp became the property of the Government. It was subsequently removed by Government forces and the camp site cleaned up by CCC enrollees.

ORRIN C. SMITH

1883–1940

ORRIN C. SMITH, engineer for the Bureau of Reclamation at Denver, Colo., died July 5, 1940, after a short illness. He was born in Clinton, Wis., November 8, 1883, and lived successively in Washington, Oregon, Nebraska, and Montana before being transferred to the Denver office in 1930. His service for the Bureau included work on several of the large reclamation projects.

Surviving Mr. Smith are his wife, Mrs. Mattie Smith; a daughter, Miss Orabell Smith, of Denver; and two brothers, C. A. Smith, of Placerville, California, and R. J. Smith, of Chicago.

Sugar Beets on Yakima Project, Washington

THE Utah-Idaho Sugar Co. has recently announced that there are 16,000 acres of valley lands on the Yakima project under contract for growing of sugar beets in 1940.

The Toppenish factory of the sugar company received a plaque of merit for outstanding efficiency in 1939 at a dinner of company officials, employees and their wives, held in Yakima early in April. The Yakima Valley plant established the record, in addition to efficiency, of processing 220,000 tons of beets, the largest number ever handled in any one factory of the Utah-Idaho Sugar Co. in its 50 years of existence.

Grand Coulee Contracts Awarded

CONTRACTS were awarded on July 19 and 20 covering respectively two phases of work on the Columbia Basin project, Washington, namely, earthwork, structures, and track for two branch lines of the Great Northern Railroad, and construction of the steel superstructure for the railroad bridge over the Columbia River at Kettle Falls, Wash., on the relocated line of the railroad.

The first of these contracts was awarded to J. A. Terteling & Sons of Boise, Idaho, on its low bid of $1,044,336.83, and the second to the American Bridge Co. of Pittsburgh, Pa., which submitted the low bid of $499,319.

The first contract includes the relocation of the Nelson and Republic branch lines, between Kettle Falls and Williams and Kettle Falls and Boyds. It involves the laying of more than 39 miles of track and the construction of necessary auxiliary structures, such as trestles, underpasses, culverts, and other minor structures. Included also are earthwork and structures for relocated highways adjacent to the railroad relocation. Rapidly rising waters in the new reservoir make it important that the work be completed on time. The contractor is required to begin work within 15 days after date of receipt of notice to proceed and complete certain features of the work within specified times and all work within 275 days.

Spring floods this year swelled the reservoir to 2,590,000 acre-feet, or more than 80,000 million gallons, and lengthened it to more than 100 miles. When full the reservoir will hold 9,517,000 acre-feet, which will make it the third largest reservoir in the United States. Stretching upstream 151 miles to the Canadian border, it will be 36 miles longer than Boulder Dam's Lake Mead, the largest man-made body of water in the world.

The second contract covers the furnishing and erecting of steel trusses, bracing, sway frames, portals, a floor system, and other miscellaneous metalwork, and in addition, the construction of the timber railroad deck, the laying of ties and rails for the track, and the installation of all lighting units. The ties, rails, and electrical equipment will be furnished by the Bureau of Reclamation, which is in charge of the entire Columbia Basin project.

Almost a quarter of a mile long, this big steel bridge will span the Columbia River at Kettle Falls at an elevation of 1,342.66 feet, or 45 feet above the water surface when the reservoir at Grand Coulee is filled. It will carry a single track.

It is important that the bridge be completed in time to permit the rerouting of the railroad traffic over the bridge before the existing railroad is submerged by the waters of the reservoir. The contractor is required to begin work within 30 days after receipt of notice to proceed, and to complete all the work within 260 days.

The Colorado-Big Thompson Project

By **M. S. BITNER**, *Associate Engineer*

CULMINATING 50 years of effort on the part of the people of Colorado to secure additional irrigation water for northeastern Colorado, the Colorado-Big Thompson project entered the construction stage in December 1938.

The principal purpose of this project is to furnish annually an estimated 320,000 acre-feet of western slope water for 615,000 acres of Colorado farm land on the eastern slope. This water will be delivered to existing eastern slope irrigation systems to complete the moisture requirements of the growing season. For contact with the Bureau of Reclamation, builders of the project, and for administration and management of the present irrigation systems the citizens in the areas to receive supplemental water created the Northern Colorado Water Conservancy District.

The general plan of the complete development from the standpoint of future operation, will extend from the vicinity of Kremmling, Colo., on the western slope of the Continental Divide to Julesburg, Colo., and the State line on the eastern slope. Both the construction features of the Colorado-Big Thompson project and the irrigation systems of the Northern Colorado Water Conservancy District will be included in the complete development. The principal towns in the district are Fort Collins, Loveland, Longmont, Greeley, Fort Morgan, Julesburg, Brush, and Sterling. Counties which will receive water from the diversion include Larimer, Boulder, Weld, Morgan, Logan, Washington, and Sedgwick.

Since the design of the project provides sufficient storage capacity and outlet points to supply water at the various locations at the time it is required, only minor adjustments in the present extensive irrigation systems of the district will be necessary in the new development.

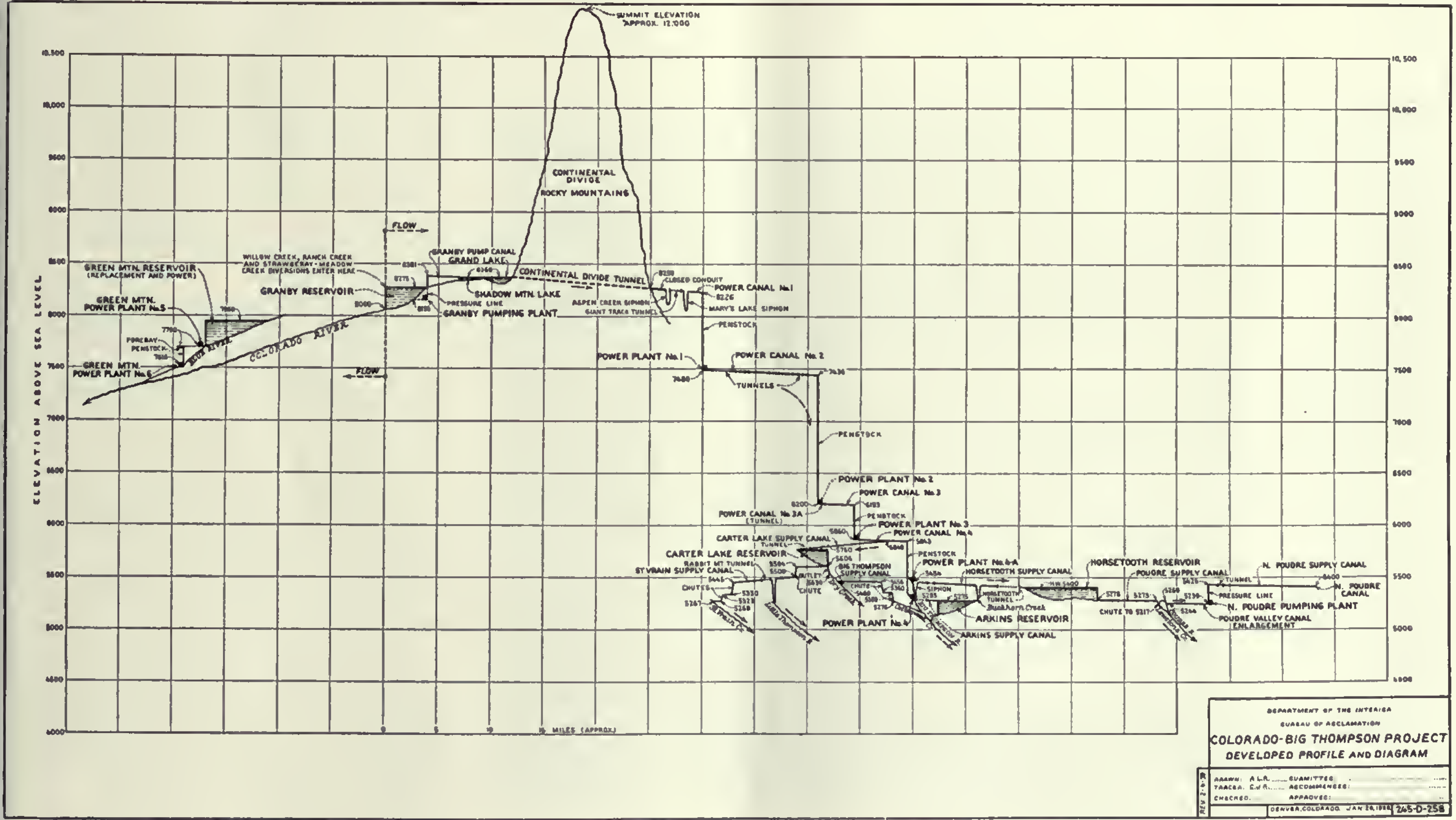
As a secondary purpose, the project will be capable of supplying annually 360,000,000 kilowatt-hours of firm hydroelectric power and 332,000,000 kilowatt-hours of secondary power. This power will be available to markets in the vicinity after the deduction of sufficient energy to operate the project.

The value of this transmountain diversion as a 40-year self-liquidating development of merit is demonstrated by the fact that the cost of supplying this water to the water district on the eastern slope is estimated to be $2 per acre-foot. Through efficient management and the taxing of assessable property to include indirect benefits in the water district the cost to the farmer for diverted water on the eastern slope should approximate $1.50 per acre-foot annually. This cost to the farmer is one-third to one-sixth the yearly averages paid in the water district at the present time. The economic worth of the project can be judged by an estimated increase of crop values of five or more times the annual cost of the western slope water. With the western slope replacement storage provided by the project, all water diverted will be in excess of present and future requirements for lands on Colorado's western slope.

Major Engineering Units

Five reservoirs, six power plants, two pumping plants, and a 13-mile tunnel comprise the major units in the project.

Green Mountain reservoir near Kremmling, Colo., was the first major unit of the project to reach the construction stage. Although none of the water from this reservoir will reach the eastern slope, it was designed and included in the project to satisfy all present



and future requirements for water on the western slope and at the same time compensate the western slope for water diverted to the eastern slope in dry years.

Green Mountain Dam will be an earthfill structure 270 feet in height and designed to impound 152,000 acre-feet of Blue River water. Power plant No. 5 will be located immediately below the dam with an installed capacity of 24,000 kilowatts.

The next project reservoir to the east on the general plan (see accompanying diagram) is Granby Reservoir. This reservoir, the largest in the project, will store a maximum of 483,000 acre-feet of water for diversion to the eastern slope. Through three 290-second-feet pumps in Granby pumping plant the water from this reservoir will be lifted an average of 130 feet by the use of off-peak power furnished principally by powerhouse No. 1 at Estes Park, Colo., and powerhouse No. 5 at Green Mountain Dam. From Granby pumping plant the diverted water will flow by gravity through 4.8 miles of canal into Shadow Mountain Lake.

The main dam at Granby Reservoir will be 228 feet in height. Three small dikes and two main supply canals, together with Granby pumping plant, will complete the required operation features for Granby Reservoir.

Following the project profile, the next unit in the diversion is Shadow Mountain Lake. This lake, with a water surface elevation the same as Grand Lake and an area more than twice that of Grand Lake, will be formed by the North Fork diversion dam located below the confluence of the North Fork of the Colorado River and the Grand Lake outlet. With both lakes serving as a compensating pool for diversion through the Continental Divide Tunnel at the east end of Grand Lake, the water surface elevation of the two lakes will not vary sufficiently in supplying diversion water to require other than off-peak power for pumping from Granby Reservoir during the daily operation. It is of interest to note that, owing to fluctuation in run-off, the water surface of Grand Lake will not vary as much during the operation of the project as it does at the present time. The present mean elevation of Grand Lake has been selected as the mean elevation for project operation. A maximum height for the North Fork diversion dam of 38 feet will be required.

Again following the profile, water pumped to Shadow Mountain Lake and a small amount diverted directly by the North Fork diversion dam will flow by gravity to the east end of Grand Lake and the west portal intake to the Continental Divide Tunnel. The tunnel intake will be designed to maintain the mean elevation of Grand Lake and will also be designed to take water from below the surface to alleviate ice trouble during winter operation if studies of past and present ice conditions warrant the additional expense. With reference to winter operation, it is of interest to note that the vast year around storage of water at approximately 39° F. in Grand Lake can be made available for operation of the canal systems below during a severely cold period on the eastern slope.

The next major unit as indicated on the project profile is the Continental Divide Tunnel. Located with portals outside the Rocky Mountain National Park, the tunnel will be constructed on a constant slope for gravity flow over its full length of 13.1 miles. With a cross-sectional diameter of 9.75 feet inside of concrete lining the tunnel is small, concurrent with a saving in construction cost. Of sufficient capacity to satisfy the annual diversion requirements and augmented by sufficient storage facilities on the eastern slope, the small size tunnel can provide a maximum amount of firm hydroelectric power through continuous operation. During spring run-off periods it may be advisable to stop diversion through the tunnel in order to derive the maximum power and storage benefits from surplus waters now available on the eastern slope.

By stopping tunnel operations temporarily the full benefit of spring run-off on the eastern slope can be derived without enlarging supply canals beyond the yearly economic limit.

During a period when the tunnel is not operating the storage facilities of Granby Dam will impound western slope run-off for future diversion.

Following the profile, water leaving the east portal of the Continental Divide Tunnel will flow into a small compensating pool formed by a rock-fill dam. This dam will be constructed from tunnel muck and designed with a concrete core-wall.

Powerhouses in operation

From the east portal pool the diverted water will enter a closed conduit and canal system 5.4 miles in length, including the 1.2 mile Giant Track Tunnel and 0.6 mile Mary's Lake siphon, and leading to powerhouse No. 1 on the Big Thompson River below Estes Park Village. Powerhouse No. 1 will require 4,900 feet of penstock, operate under an effective head of 704 feet, and have an installed capacity of 30,000 kilowatts.

From powerhouse No. 1 water will discharge into the Big Thompson River or, if there should be a market for the full power development of diverted water at the time it is available, this water will be diverted, together with any surplus water in the Big Thompson River, into 10.6 miles of gravity power canal and tunnel leading to powerhouse No. 2. Powerhouse No. 2, located on the North Fork of the Big Thompson River near Drake, Colo., is the largest proposed on the project. This powerhouse will require 4,150 feet of penstock, operate under a head of 1,195 feet, and have an installed capacity of 50,000 kilowatts.

From powerhouse No. 2 water will be diverted into 2.9 miles of canal and 650 feet of penstock to powerhouse No. 3, located on the bank of the Big Thompson River a short distance above the present Loveland, Colo., municipal hydroelectric plant.

Below powerhouse No. 3 water will be

General view of Government camp

diverted and divided to supply canals for both Carter Lake reservoir, the largest of the eastern slope storage reservoirs, and powerplants No. 4 and 4A.

Power plant No. 4 will be located on the Big Thompson River about 2 miles east of Cedar Cove at the lower end of the Big Thompson Canyon. Power plant No. 4 will operate under a head of 550 feet with an installed capacity of 16,000 kilowatts and discharge directly into the Big Thompson River.

Power plant No. 4A will be located a short distance upstream from plant No. 4 and 175 feet above the river. Water from plant No. 4A will be carried by siphon and 9.9 miles of canal to Horsetooth Reservoir, which is the second storage reservoir in size on the eastern slope.

Storages

The third eastern slope storage reservoir, the smallest and the lowest in elevation is Arkins Reservoir. With a storage capacity of about 50,000 acre-feet, Arkins Reservoir will receive its supply by diversion into canal from the Big Thompson River below power plant No. 4. The dam at Arkins Reservoir will be an earth structure 143 feet in height across Buckhorn Creek west of Loveland. Water from the Arkins Reservoir will discharge into the Big Thompson River and ditches in the vicinity.

Carter Lake Reservoir, as previously pointed out, is the largest of the three eastern slope reservoirs with a storage capacity of 110,000 acre-feet. This reservoir will be formed over the existing Carter Lake by one main earthfill dam 240 feet in height and two small earthfill structures 70 and 50 feet in height.

From Carter Lake Reservoir, 15.29 miles of supply canals to the St. Vrain and Big Thompson Rivers will be constructed for access to these two drainage areas and for supplying water to irrigation systems of the Northern Colorado Water Conservancy District intercepted along the routes of the canal system.

Horsetooth Reservoir, mentioned before as the second in size of the project's eastern slope reservoirs will be formed by four large earthfill structures and will exceed 6 miles in length. Horsetooth Dam, at the north end of this reservoir, will have an effective height of 128 feet. Soldier Canyon Dam, the northernmost of the three structures on the east side of the reservoir, will be 193 feet high. Dixon Canyon, the middle dam on the east, will be a structure 195 feet in height. The fourth dam on Horsetooth Reservoir, located at the southeast end, will be Spring Canyon Dam, a structure 180 feet high.

The main supply of water to the water district from Horsetooth Reservoir will be discharged into the Cache La Poudre River area northwest of Fort Collins, Colo. A small amount of this water, approximately 150 second-feet, will pass through the North Poudre pumping plant to supply higher ditches in the vicinity.

Administration area from top of little Prospect Mountain, ¾-mile west of area, looking east

Transmission line, Loveland to east portal of Continental Divide Tunnel

When construction of the supply canals in the vicinity of the project's eastern slope storage reservoirs begins, the size of the reservoir discharge canals will be noticeably large when compared with the canals supplying the reservoirs. This noticeable difference in design is explained by the fact that, as supplemental irrigation water, a year's storage in the eastern slope reservoirs will be delivered to the Northern Colorado Water Conservancy District in a period varying from 60 to 75 days during the latter part of the growing season.

Preconstruction Investigations—Tucumcari Project, New Mexico

By H. W. MUTCH, *Resident Engineer*

THE Tucumcari project, comprising some 81,000 acres of land, of which 47,300 acres are irrigable, is located in Quay County, in the east central part of the State of New Mexico. The project area was originally homesteaded for dry-land farming purposes, but a succession of years deficient in rainfall caused the lands to revert to grazing uses. The project contemplates rehabilitating the area by constructing a 65-mile main canal leading from Conchas Reservoir, on the South Canadian River, to lands near the town of Tucumcari. Although the reservoir was constructed primarily for flood-control purposes, 300,000 acre-feet of water have been made available for irrigation use without charge to the water users. It is expected that the principal products will consist of grain, alfalfa, and other forage crops which will be utilized by the livestock interests surrounding the project.

Surveys

The project was first investigated by the State of New Mexico at the time Conchas dam and Reservoir were being constructed by the United States Engineer Corps. A reconnaissance survey was made by the Bureau of Reclamation in March 1936. Authorization of a detailed investigation was made in July 1936, and surveys were started in October of that year.

The entire upper portion of the canal is at a considerable distance from town, and as the canal location crossed rough, broken terrain without roads or trails, it was desirable to conduct this portion of the survey from the Conchas Dam. The Army engineers furnished quarters and supplies for survey men and also cooperated to the fullest extent in other matters.

The upper 38-mile section of the canal location parallels a high mesa and crosses a number of dry washes or arroyos. This section lies within the lands of the Bell Ranch, owned by the Red River Valley Co., and was formerly a part of the Pablo Montoya Spanish Land Grant. A triangulation system was established and a chained traverse made of the final location. A large portion of the area in the Pablo Montoya Land Grant was not surveyed in sections, but ties to land office corners were obtained where possible. Detail topographic surveys were made at all the principal structure sites. Topography was also taken along the center line of the canal for about 50 miles. Canal lines were run the full length of the project to determine the upper boundaries of the irrigable area.

Diamond drill explorations were made to ascertain the materials to be excavated at heavy cuts and tunnel locations. Generally speaking, the formation encountered throughout the length of the main canal is shale and soft sandstone. The soil is quite impervious and concrete lining is not required except in short reaches of the canal. Owing to the rapid erosion to which this region is subjected, it was decided that the siphon type of structure would provide the most satisfactory method of crossing the numerous arroyos. Thirty siphons and four tunnels are required in the canal system. The total length of tunnels is approximately 5.2 miles, and the total length of the siphons, 10 miles. The longest tunnel and siphon are 9,656 and 4,696 feet, respectively. Other major structures include 7,064 feet of concrete lining and 1,442 feet of bench flume.

An abandoned homestead. Trees are dying from lack of water. Windmill is rusting and falling apart

Land Classification

The land classification was made on plane-table sheets with a scale of 1,000 feet to the inch. All boundary lines between the irrigable and nonirrigable lands were mapped by stadia surveys. Level lines were run to locate the high land below the canals. In general the project areas have a uniform slope or gently undulating topography, and will require a minimum of leveling for irrigation.

The predominating soils of the project are of a dark, reddish-brown color, largely originating from erosion of sedimentary formations. The soil generally has a depth in excess of 12 inches. It ranges from a sandy clay loam to a silty clay loam with a comparatively tight subsoil.

The project lands were separated into three classes of irrigable land. Classes 1 and 2 are considered to have sufficient agricultural value to repay construction charges. Class 3 lands may produce a crop of native hay, but are not considered to have sufficient agricultural possibilities to meet assessments for construction purposes.

The irrigable lands as classified were as follows: Class 1, 16,500 acres; class 2, 30,800 acres, and class 3, 2,500 acres.

The irrigable lands of the project are traversed by a number of dry washes and creeks, which will provide outlet channels for such drainage as may be required. These arroyos are dry except during the rainy periods which cause a temporary flow in the spring and occasionally in the summer. Torrential rains cause some of the creeks to carry flash floods of considerable size. Part of the project lands have a tight subsoil and it is anticipated that short local drains will be necessary to relieve seeped areas and carry the return flow to the natural channels.

Project Plans

The water supply will be obtained from the South Canadian River, principally from stored flood waters. The average annual draft is estimated at 135,000 acre-feet. Live storage capacity of 300,000 acre-feet is made available at the Conchas Reservoir. This dam and reservoir were constructed by the United States Engineer Corps, War Department, as a dual purpose reservoir without charge to irrigation interests.

The main canal has an initial capacity of 700 second-feet and a length of 75 miles. The Hudson Canal, capacity 254 second-feet, diverts from the main canal at mile 56. The capacity of the main canal beyond this point is 250 second-feet. A dry lake bed at mile 63 offers a reservoir site (700 acre-feet capacity) which may be used as a regulatory reservoir. Construction of drains will be necessary to provide adequate drainage.

The estimated project cost of $8,155,000 includes construction of the canals, lateral, and drainage systems.

Construction of Project

After completion of the detailed investigation report, the Arch Hurley Conservancy District was organized under the then existing laws of the State of New Mexico to promote construction of the project. It was not known whether construction of the project would be authorized by Congress or whether it might be built by the conservancy district.

As a result of a finding of feasibility, the Bureau of Reclamation was authorized, by an act of the Seventy-fifth Congress, to construct the Tucumcari project, as described in the report. The total estimated cost of the project ($8,155,000) was far in excess of the repayment ability of the project lands, and a nonreimbursable grant of $2,500,000 was obtained with which to start construction. The remaining $5,655,000 was to be collected by the conservancy district and repaid to the United States in 40 years without interest. It was found that there were no provisions under the laws of the State of New Mexico whereby a conservancy district could enter into such a contract. Therefore, a bill authorizing contractual relationship between the conservancy district and the United States was passed by the fourteenth State legislature during the early spring of 1939. This act was known as Senate bill No. 133, "*An act to provide for cooperation between conservancy districts, heretofore or hereafter organized, and the United States of America under the terms of the Federal Reclamation laws, authorizing and validating existing or future contracts for that purpose, making contract indebtedness a general obligation of such districts and providing for the classification of State, public and private real property in such districts, for the apportionment, lien, levy, and collection of assessments, tolls, and charges for the payment of contract indebtedness, providing for the distribution of the water supply, prescribing the powers and duties of certain district and county officers, and declaring an emergency.*"

Final Surveys

An office was established at Tucumcari and an organization started in October 1939. A field office was located at the Conchas Dam to make minor revisions of the canal loca-

Upper: Homestead along the Norton Road. A better class farm
Center: Survey party at outlet portal of tunnel No. 2 just after the tunnel had been started into the stratified hillside
Lower: Excavation work at inlet portal of tunnel No. 1. The town of Conchas Dam is in the right background

tion preparatory to advertising for bids on construction. Office space and other facilities were provided by the United States Engineer Corps. The total force now consists of about 200 employees.

A final location has been made for the first fifty miles of the main canal, and land classification and topographic surveys are in progress. Inasmuch as there were very few existing corners and quarter-corners intact over the project area, the General Land Office was requested to make the necessary relocation surveys and establish center corners as well. The General Land Office has completed the field work and a final report and revised survey plats are under preparation. Topography is being taken over the entire project area on a horizontal scale of 400 feet to 1 inch and with 2-foot contour intervals. This is considered necessary in planning and designating the lateral system and also in the laying out of farm units.

Detail land classification.—A soils technician, directed by Hydraulic Engineer E. B. Debler and Associate Reclamation Economist E. R. Fogarty, has been making the detailed land classification with the assistance of a planetable party and several laborers. This work is now complete and the planning of the distribution system is being carried out. It is contemplated that the irrigable areas of each 40-acre tract will be determined prior to January 1, 1941.

Rights-of-way.—A right-of-way agreement has been executed by the Red River Valley Co. for the first 38 miles of canal. It is believed that this has the distinction of being the longest right-of-way acquired under one contract by the Bureau of Reclamation. Rights-of-way will be obtained from the State for works to be constructed on State and school lands after the final location has been completed.

Construction

Advertisements were prepared and bids opened at the project office on November 16, 1939, for the construction of the first 20 miles of the Conchas Canal. These include all excavation, three tunnels, and other canal structures. The work was divided into five schedules, and a total of 29 bids was received. Satisfactory bids were obtained on all schedules, and contracts totaling $1,946,009 were awarded as follows:

Schedule No. 1, Utah Construction & Griffith Co., $562,027; schedules Nos. 2, 3, and 4, Jahn-Bressi-Bevanda Co., $1,309,582; and schedule No. 5, Brown & Root, Inc., $74,400.

Participation by WPA

A construction program, including excavation and structures on 11½ miles of the Conchas Main Canal from the San Miguel Quay county line to the city limits of Tucumcari, is now ready to be submitted to the WPA State administrator. This program is based on the number of men on relief rolls in the locality. This part of the construction program is being vigorously prosecuted, as the project is more or less contingent upon such relief measures and it is felt that a great deal of good will be accomplished through the use of relief workers.

One requirement under the State WPA plan is that the Federal agency must contribute at least 25 percent of the cost of the project. This contribution may consist of materials and equipment or anything else necessary to complete a project with the exception of labor, which is supplied by WPA. It is doubtful whether dragline and shovel operators or men in other skilled positions can be supplied from their eligible rolls, as their wage scale is much lower than contractor rates.

Contract work was initiated March 17, 1940, and at the close of the month of April all three contractors had made a good showing, confined largely, however, to earthwork and processing of concrete aggregates.

Work by Government forces, consisting largely of fencing rights-of-way and building construction and operation roads, was nearly completed at the close of April 30, 1940, covering the 24 miles of work let by contract.

In the vicinity of Tucumcari, 1½ miles of the Conchas Canal have been excavated by Government-operated dragline equipment, and several structures to be built by WPA forces are to be so excavated.

The work to be done under WPA plans is expected to be in full operation shortly. Approval by Presidential letter has been received by the State WPA administrator for a warehouse, in addition to the canal structure proposal. There is pending at this time a WPA proposal to construct a project office building on a 10-acre tract of land acquired from the city of Tucumcari by a gift warranty deed.

Farm Units and Settlement Plans

The project area is largely privately owned land which was homesteaded prior to 1910. Most of the original homesteaders sold their holdings to livestock men after failing to make a success of dry-land farming. There remain about 400 acres of public land which have been placed under the second form of withdrawal. The project also includes about 4,300 acres of State and school lands.

A considerable portion of the irrigable land is owned by relatively few individuals. Excess land agreements were executed by these individuals providing for the disposition of land in excess of 160 acres in a single ownership. An appraisal has been made of the market value of the project lands in the present undeveloped condition in conformity with the provisions of the contract. After the detailed land classification has been completed and plans for the distribution system are perfected, farm units will be established and transfer of the excess holdings will be encouraged. In accordance with instructions, the project office is listing all lands offered for sale.

Inasmuch as it will be several years before water can be delivered to any appreciable portion of the project, it is not considered necessary to prepare definite settlement plans at this time. State and county officials, representatives of the Rock Island Railroad, and other Government agencies are cooperating in the various problems connected with the resettlement of the project lands.

Lake Mead Storage

THE Soil Conservation Service of the Department of Agriculture has recently completed studies for the Bureau of Reclamation of the storage capacity of Lake Mead, Boulder Canyon project, which it now places, through a detailed and exact survey, at 32,359,274 acre-feet, exceeding the estimated figure by 1,859,274 acre-feet.

Actual storage in Lake Mead at present is 24,191,000 acre-feet. Winter snowfall in the mountains of the Colorado River Basin appears sufficient to assure an adequate inflow of water for the development of power and irrigation in the project area without drawing on this storage. The upper 9,500,000 acre-feet of total storage capacity is reserved for flood control. All of this storage space can be made available at the beginning of each year's flood season if snow surveys and other hydrologic data indicate that it is needed.

The present demand for irrigation and power is about 8,000,000 acre-feet per year. Even if the Colorado River should dry up entirely for a whole year or more, farms dependent upon waters of the lower Colorado for irrigation would not suffer and the huge generators of the Boulder Dam power plant could continue to supply power to the Los Angeles metropolitan area and the Southwest.

Lake Mead extends 115 miles up the Colorado River from Boulder Dam with 550 miles of shoreline and has about twice the storage capacity of any other man-made lake, with the exception of the Fort Peck Reservoir on the Missouri River in Montana, which has a capacity of 19,412,000 acre-feet and ranks second in storage capacity among the important reservoirs of the United States. The Grand Coulee Reservoir on the Columbia River will rank third with a total storage capacity of 9,517,000 acre-feet.

NOTES FOR CONTRACTORS

Specification No.	Project	Bids opened	Work or material	Low bidder		Bid	Terms	Contract awarded
				Name	Address			
		1940						*1940*
909	Colorado River, Tex	June 14	Completion of Marshall Ford Dam.	Brown & Root and McKenzie Construction Co.	Austin and San Antonio, Tex.	[1] $3,137,495.00		July 29
913	Columbia Basin, Wash	July 8	Rearing ponds, diversion dam, dike, roads, and drainage and water systems for the Entiat station for migratory fish control.	W. T. Butler Co. and Olav Boen.	Seattle, Wash	84,334.25		July 26
916	Parker Dam Power, Calif.-Ariz.	July 18	Synchronous condensers and control equipment for Phoenix terminal substation.	General Electric Co	Schenectady, N. Y.	289,650.00	F. o. b. Schenectady, Fort Wayne, Ind., Pittsfield, Mass., and Philadelphia, Pa.	Aug. 6
917	Boulder Canyon, Ariz.-Nev.	July 17	Hydraulic turbine, governor and pressure regulator for unit A-5, Boulder power plant.	Allis-Chalmers Manufacturing Co.	Milwaukee, Wis	[2] 584,000.00	F. o. b. West Allis, Wis	Aug. 1
				Woodward Governor Co	Rockford, Ill	[3] 25,500.00	F. o. b. Rockford	Do.
1375-D	Rio Grande, N. Mex.-Tex.	June 28	Carrier-current telephone apparatus for Elephant Butte power plant.	General Electric Co	Schenectady, N. Y	[4] 6,168.00	F. o. b. Engle and Las Cruces, N. Mex.	July 24
1379-D	Central Valley, Calif	July 15	3 motor-driven sweeps for cleaning fish screens.	Valley Iron Works	Yakima, Wash	4,215.00	Discount 5 percent. F. o. b. Yakima.	Do.
1380-D	Yakima-Roza, Wash	July 16	Slide gates, gate stem guides and motor-operated gate hoists.	Western Foundry Co	Portland, Oreg	[5] 1,732.00	F. o. b. Portland	July 25
1381-D	Columbia Basin, Wash	July 15	Lifting frames for bulkhead gates and trash racks.	Valley Iron Works	Yakima, Wash	1,130.00	Discount 5 percent. F. o. b. Yakima.	Do.
1382-D	Colorado River, Tex	July 10	470,000 barrels of low-heat portland cement in bulk.	Longhorn Portland Cement Co.	San Antonio, Tex	759,520.00	F. o. b. Rutledge, Tex. Discount 10 cents per barrel.	Aug. 2
E-23,062-A	Boulder Canyon, Ariz.-Nev.	July 18	8,000 barrels of standard portland cement in paper sacks.	Southwestern Portland Cement Co.	Los Angeles, Calif	11,200.00	F.o.b.Victorville, Calif	July 30
B-38,409-A	Columbia Basin, Wash	July 25	Galvanized corrugated-metal pipe and coupling bands.	Beall Pipe & Tank Co	Portland, Oreg	[1] 4,762.67	F. o. b. Portland	
				Young and Greenawalt	Chicago, Ill	[6] 20,423.95	F. o. b. E. Chicago, Ind	Aug. 6
24,749-A	Gila, Ariz	July 23	Steel reinforcement bars (1,221,000 pounds).	Bethlehem Steel Co	San Francisco, Calif	29,263.50	F. o. b. Arahy, Ariz. Discount ½ percent on 36 cents less than bid prices.	Aug. 7
B-42,493-A	All-American Canal, Ariz.-Calif.	do	Steel reinforcement bars (1,840,000 pounds).	Judson Steel Corporation	Oakland, Calif	44,756.00	F. o. b. Frink, Calif. Discount ½ percent.	Aug. 7
1378-D	Rio Grande, N. Mex.-Tex.	July 8	Transformers, disconnecting switches, oil circuit breakers and lightning arresters for Elephant Butte power plant and Hot Springs substation.	American Transformer Co	Newark, N. J	[7] 3,010.00	F. o. b. Engle, N. Mex	Aug. 1
				do	do	[8] 2,945.00	F. o. b. Hatch, N. Mex	Do.
				Kelman Electric & Manufacturing Co.	Los Angeles, Calif	[9] 1,041.00	F. o. b. Engle, N. Mex	Aug. 2
				General Electric Co	Schenectady, N. Y	[10] 179.00	do	Aug. 3
				do	do	[11] 179.00	F. o. b. Hatch, N. Mex	Do.
				do	do	[12] 138.00	F. o. b. Engle, N. Mex	Do.
				Westinghouse Electric & Manufacturing Co.	Denver, Colo	[13] 72.00	do	Do.
				do	do	[14] 72.00	F. o. b. Hatch, N. Mex	Do.
1389-D	Columbia Basin, Wash	July 31	Structural steel for Grand Coulee power plant.	Tulsa Boiler & Machinery Co.	Tulsa, Okla	5,818.00	F. o. b. Odair, Wash. Discount ½ percent.	Aug. 7
D-23,493-A	Boulder Canyon, Ariz.-Nev.	June 24	Gasoline-engine generator set	LeRoi Co	Milwaukee, Wis	10,600.00	F. o. b. Milwaukee. Discount 1½ percent.	Aug. 10
1383-D	Columbia Basin, Wash	July 18	Twenty-three 150-kilovolt-ampere, outdoor, distribution-type transformers.	American Transformer Co	Newark, N. J	50,692.00	F. o. b. Odair, Wash	Aug. 1
1385-D	Central Valley, Calif	July 23	Clearing a part of the Shasta reservoir site.	Wixson and Crowe	Shasta Dam, Calif	[4] 65,000.00		Aug. 14
1386-D	Columbia Basin, Wash	July 25	Furnishing and installing refrigeration equipment for cold-storage and heating plant at Leavenworth station.	York Ice Machinery Corporation.	York, Pa	[5] 13,599.00	F. o. b. shipping points	Do.
41,502-D	Buffalo Rapids (second division) Wash.	July 23	Crawler tractors and carry-all scrapers.	Caterpillar Tractor Co	Peoria, Ill	[5] 16,230.00	F. o. b. Peoria. Discount $250.	Aug. 13
918	Parker Dam Power, Calif.-Ariz.	July 11	Oil circuit breakers disconnecting switches, instrument transformers and lighting arresters for the Phoenix terminal substation and Parker power plant.	Kelman Electric & Manufacturing Co.	Los Angeles, Calif	[1] 214,849.00	F. o. b. Phoenix, Ariz. and Earp, Calif.	Aug. 15
				Westinghouse Electric & Manufacturing Co.	Denver, Colo	[3] 48,514.00	do	Do.
				Electric Power Equipment Corporation.	Philadelphia, Pa	[15] 46,606.00	do	Aug. 9
				Allis-Chalmers Manufacturing Co.	Milwaukee, Wis	[16] 12,920.00	do	Do.
				General Electric Co	General Electric Co	[17] 18,042.00	do	Do.
				Westinghouse Electric & Manufacturing Co.	Denver, Colo	[18] 10,179.18	do	Aug. 15
921	Columbia Basin, Wash	July 24	Power transformers for units L-1 and L-2, Grand Coulee power plant.	General Electric Co	Schenectady, N. Y	570,159.00	F. o. b. shipping points	Do.
922	Boise-Payette, Idaho	do	Earthwork and structures for Graveyard Gulch and Langley Gulch wasteways.	Vernon Brothers	Boise, Idaho	84,572.50		Do.

[1] Schedule 1. [2] Schedules 1 and 3. [3] Schedule 2. [4] Schedules 1 and 2. [5] Items 1 and 2. [6] Schedules 2 and 3. [7] Item 1. [8] Item 2. [9] Item 3. [10] Item 4. [11] Item 5. [12] Item 6. [13] Item 7. [14] Item 8. [15] Schedule 3. [16] Schedule 4. [17] Schedule 5. [18] Schedule 6.

Bound Eras for 1939 Received

THE Bureau has just received from the Government Printing Office the bound issues of THE RECLAMATION ERA. There is a limited edition. Single copies cost $1. Checks or money orders should be made payable to the Treasurer of the United States and mailed to The Commissioner, Bureau of Reclamation, Department of the Interior, Washington, D. C.

New Edition Hydraulic and Excavation Tables

THE eighth edition of Hydraulic and Excavation Tables is just off the press. It is a reprint with some new tables and text added.

The first edition of the book was issued by the Bureau in 1905. It is published primarily for official use of the engineers of the Bureau. Size 4½ by 7 inches; cloth-bound. Copies may be obtained by the public for $1.50 a copy. Checks or money orders are acceptable, made payable to the Treasurer of the United States and mailed to The Commissioner, Bureau of Reclamation, Department of the Interior, Washington, D. C.

A special price of $1 a copy is quoted to other Government agencies, where the volume is for official use. It is used by some universities and colleges as a textbook, and supplies are ordered each year for new classes.

Five-Acre Tract Act of 1938

UNDER regulations issued by the United States General Land Office and approved by Secretary of the Interior Harold L. Ickes on June 10, 1940, small areas of land in the public domain outside of certain national reservations are made available for home site, cabin, camp, health, convalescent, recreational, or business purposes, to any person who is the head of a family or is 21 years of age and is a citizen of the United States or has declared his intention of becoming such citizen, as required by the naturalization laws.

As stated by Secretary Ickes, "it is the policy of the Department of the Interior in the administration of the Five-Acre Tract Act to safeguard the public interest in the lands as an integral part of the national conservation program.

"To this end, applications for sites will be considered in the light of their effect upon the conservation of natural resources and upon the welfare, not only of the applicants themselves, but of the communities in which they propose to settle.

"Applications will not be allowed, for example, which would lend to private ownership or control of scenic attractions or water resources that should be kept open to public use. Settlement will not be permitted which would contribute toward making public charges of the settlers. Nor will isolated or scattered settlements be permitted which would impose heavy burdens upon State or local governments for roads, schools, and police, health and fire protection. Types of settlements or business which might create 'eyesores' along public highways and parkways will be guarded against.

"Since the land is not intended to be devoted to producing a living, unless allocated for business, the applicant must furnish satisfactory evidence of resources insuring financial responsibility adequate to maintain himself and family and successfully to carry out the undertaking for which he proposes to use the land." The regulations provide that applications may be submitted on or after August 9, 1940 to the register of the district land office in which the land sought is located, and must be accompanied by a filing fee of $5.

Filing of the application, it is emphasized, will not give the applicant the right to occupy the land or commence improvements thereon, although it will serve to segregate the tract from other disposition pending final determination of the request.

Under the law, rights to the minerals or oil and gas deposits in lands to be leased under the Five Acre Tract Act are reserved to the United States, and timber cutting for the purpose of clearing the land or making improvements will not be allowed without special permit from the Commissioner of the General Land Office.

Other safeguards for prudent use of the land under the national conservation program are contained in the regulations. For example, the application filed must contain information as to the source of water proposed to be secured for domestic use, and the nature of sanitary facilities to be provided on the tracts.

Moreover, the applicant must state the distance from the tract applied for to the nearest improved road, school, and town, village or trading center, and, if the site is to be used for business purposes, he must agree to conduct all business operations in an orderly manner and in accordance with all requirements of State and Federal laws.

If, after examination, it is found that the application involves land which properly may be classified as subject to utilization under the terms of the Five-Acre Tract Act, a lease for 5 years may be offered at an annual rental, payable in advance, to be fixed by the Secretary of the Interior.

Description of the types of sites contemplated under the act is contained in the regulations, as follows:

A home site is one suitable for a permanent, year-round residence for a single person or a family; a cabin site is one suitable for a summer, week end, or vacation residence, and a camp site is one suitable for temporary camping and for the erection of simple or temporary structures and shelters, such as tents, tent platforms, etc.

Health sites are defined in the regulations as those suitable for the temporary or permanent residence of a single person or of a family for the prevention or cure of disease or illness, while a convalescent site would be one suitable for residence for the purpose of recuperation from a disease or illness.

A recreational site is one chiefly suitable for noncommercial outdoor recreation, and a business site is one suitable for some form of commercial enterprise.

Compulsory Registration of Aliens

AN important step in our national defense program has been taken in the passage by Congress of the Alien Registration Act of 1940, which act requires the registration and fingerprinting of all aliens above 14 years of age, and the registration by parents or guardians of aliens under that age. Actual registration and fingerprinting must be accomplished within the period from August 27 to December 26 of this year.

The Immigration and Naturalization Service of the Department of Justice has issued a circular of instructions, which includes a specimen form for alien registration. This form filled out and taken to the post office will expedite registration, as the alien will there be asked to give the information indicated on the form, to swear to (or affirm) its truth, and to be fingerprinted.

Registration is free. The alien should not pay anyone to register for him, and it is not necessary for him to pay any person or group to assist him in registering. The Government, through its post offices, will render all possible assistance.

The Alien Registration Act was passed so that the United States could determine exactly how many aliens there are, who they are, and where they are. Registration, including fingerprinting, will not be harmful to law-abiding aliens. All records will be kept secret and confidential and will be made available only to such persons as may be designated with the approval of the Attorney General of the United States.

When President Roosevelt signed this act, he said: "The registration . . . does not carry with it any stigma or implication of hostility towards those who, while they may not be citizens, are loyal to this country and its institutions. Most of the aliens in this country are people who came here because they believed and had faith in the principles of American democracy, and they are entitled to and must receive full protection of the law."

Title 18, section 52 of the United States Code makes it a crime, punishable by fine and imprisonment, to deprive any inhabitant of the United States of his rights under the laws and Constitution because of his being an alien. This Federal law will be strictly enforced by the United States Department of Justice.

A receipt card will be sent to every alien who registers. This card will serve as evidence of registration.

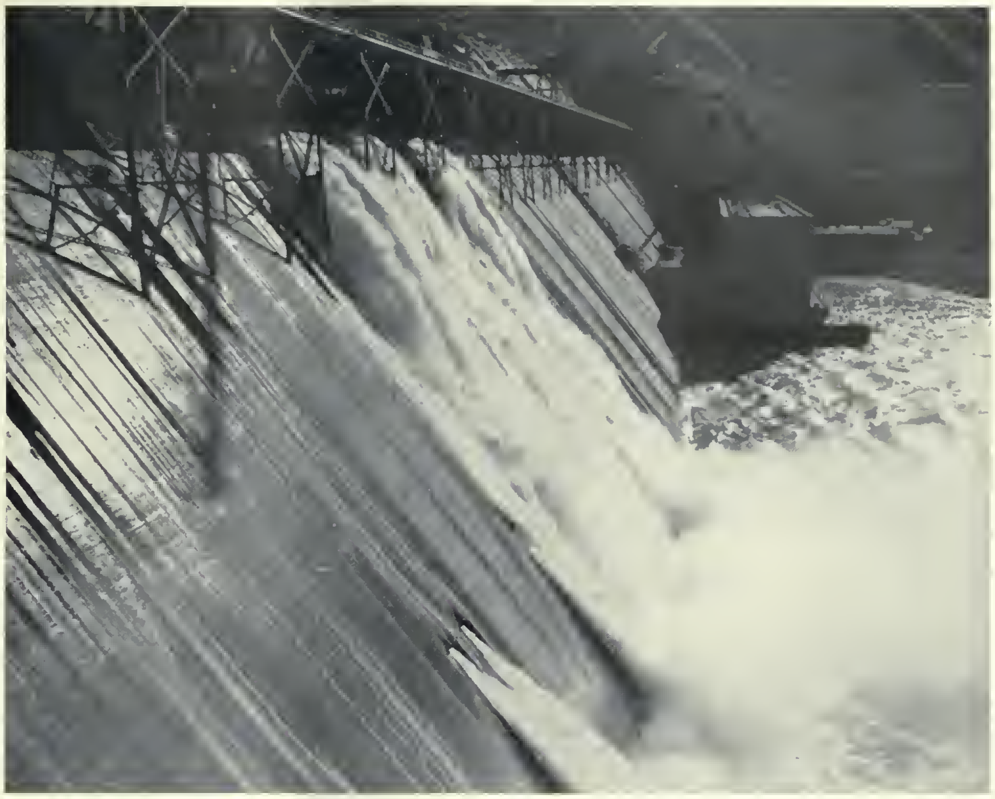
After registration, the law requires all aliens and parents or guardians of aliens to report changes of residence address within 5 days of the change to the Immigration and Naturalization Service, Department of Justice, Washington, D. C. Forms for this purpose may be obtained at post offices.

To a Waterfall

THE waterfall has come and gone. As it was born—gradually, in green and white multiples of 50 feet—so it died. For 41 days it made a lovely sight. Fifty-three thousand visitors at the dam will bear witness that it really happened.

From the 26th of May until the 7th of July the Columbia River, dropping 200 feet over the center of Grand Coulee Dam and resembling a mint ice cream soda, created a waterfall. During the first 5 months of this year the outlet conduits, like plumbing pipes through the spillway section of the dam, carried the river's flow through the great concrete barrier. But their total capacity was not enough to bypass the peak flow that comes in early summer from the melting snows and ice of the Canadian Rockies. Seventeen blocks in the middle section of the dam were therefore left lower than their neighbors, the heights of these blocks were staggered, and work in that area was suspended.

Locally great interest, and some speculation in the form of an unofficial pool, centered on the exact time the fast swelling reservoir behind the dam would spill. On May 26 the torrent surged over the two lowest blocks. Each day it grew until on the 5th of June the spectacle reached a climax. Fifty-four outlets and nine slots shot forth a huge volume of water and spray, 850-feet wide and taller than Niagara, the flood peak of the great Columbia River. Six days this waterfall kept its peak; gradually the volume diminished.



Water pouring over central spillway section, Grand Coulee Dam, Wash.

Poems have been written to waterfalls. Engineers, however, are busy practical men. At the dam the daily report of July 7, marking this waterfall's death reads: "Block 44 sand-bagged off—will be concreted tomorrow."

Today the waterfall is a memory. But next summer, over the completed dam, it will return—wider, and more than twice the height of Niagara.

Departmental Order Gives Official Assignments

UNDER Departmental Order No. 1485, dated May 18, 1940, Secretary of the Interior Harold L. Ickes has made the following assignment of offices and functions of the Department of the Interior:

UNDER SECRETARY OF THE INTERIOR

1. National Park Service.
2. Bureau of Reclamation.
3. Bonneville project.
4. Bureau of Biological Survey.
5. Bureau of Fisheries.
6. Grazing Service.
7. Bituminous Coal Division.
8. United States Board of Geographic Names.

FIRST ASSISTANT SECRETARY OF THE INTERIOR

1. General departmental administration.
2. Office of Chief Clerk of the Department.
3. Office of Director of Personnel.
4. Office of Supervisor of Classification.
5. The Budget.
6. Office of the Representative, Advisory Council, Civilian Conservation Corps.

ASSISTANT SECRETARY OF THE INTERIOR

1. General Land Office.
2. Geological Survey.
3. Bureau of Mines.
4. Bureau of Indian Affairs.
5. Petroleum Conservation Division.
6. Division of Territories and Island Possessions.
7. Eleemosynary Institutions.

SOLICITOR FOR THE DEPARTMENT

1. In the absence of the Secretary, the Under Secretary will act as Secretary of the Interior. In the absence of the Secretary and the Under Secretary, the senior Assistant Secretary on duty will act as Secretary.

2. In the absence of the Secretary, the First Assistant Secretary will sign personnel orders.

3. The First Assistant Secretary, under the supervision of the Secretary, will be the general administrative officer of the Department.

4. The Division of Investigations and the Office of Information, which office shall supervise the Photographic and Publications Sections, will be under the direct supervision of the Secretary of the Interior.

5. The Chief Clerk will have immediate supervision over the Purchasing Office, War Minerals Relief, the Miscellaneous Service Division, the Mail and Files Sections, the Office of Exhibits, the garage, the dispensary, and the telephone service. He will sign specially designated papers and documents in the absence of the Assistant Secretary.

6. This order supersedes orders No. 1312 and No. 1438 dated September 15, 1938, and January 4, 1940.

Power Operations at Boulder Dam

UNDER the existing 50-year power contracts the revenues from the sale of power at Boulder Dam from July 1, 1937, to the close of June 30, 1940, amounted to approximately $11,300,000, and total repayments to the United States Treasury from the power plant since the beginning of operations on October 11, 1936, have amounted to about $10,200,000. The gross income thus far for the 3 years of power operations exceeds by about $2,000,000 the amount anticipated when financial plans were formulated for this pioneer among the Government's multipurpose hydroelectric projects. Revenues from this source have shown a steady increase, $247,723 for the years 1936–37, with four generators in operation and with the income under temporary interim contracts which disposed of power at secondary rates, to $3,835,690 under the regular 50-year contracts for the years 1938–39. With only 9 of Boulder's capacity 17 generators installed, the gross income has been averaging more than $350,000 a month or well over $4,000,000 annually.

The cost of the Boulder Dam reservoir and power plant as of June 30, 1939, exclusive of interest, was $116,128,135. There has been an unexpected demand for power from the Boulder plant ever since the dam was completed in 1935, and pressure was at the outset put on the Bureau's construction forces to place the first unit in action at the earliest possible date.

The first customer was the city of Los Angeles, to which power was transmitted October 9, 1936, and the city celebrated the event with a "Pageant of Light," when huge arc lights on the city hall blazed with electricity sent from Boulder, 266 miles away.

Power generation at Boulder by calendar years has shown the effects of the growing demand for energy. In 1936, the plant generated 123,933,000 kilowatt-hours; in 1937, 1,180,143,000; in 1938, 1,522,627,000; and in 1939, 2,507,932,000.

Boulder now has 10 high-tension transmission lines extending from its power plant to customers hundreds of miles away. Two lines extend to Los Angeles; another line goes to Chino, Calif., 233 miles off; and a third goes to San Bernardino, Calif., 222 miles distant. Other lines go to Hayfield, Calif.; Parker, Ariz.; Kingman, Ariz.; Needles, Calif.; Pioche, Nev.; and Las Vegas, Nev.; and, of course, to Boulder City.

In addition to making available to the southwestern United States large blocks of low-cost electric energy, the gigantic multipurpose irrigation project built by the Bureau of Reclamation creates other valuable benefits.

The Boulder Canyon project renders remote the danger from destructive Colorado River floods, provides an invaluable water supply for irrigation and domestic use, and has created an increasingly important recreational center and wildlife refuge.

Commissioner Page, in his statement to Secretary of the Interior Ickes, aptly said: "Three years of permanent contract operation of Boulder Dam has conclusively demonstrated that the project is one of the Government's finest investments. It will pay its own way and bring great benefits to the entire Southwest. The Bureau is proud of being its creator."

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CUT ALONG THIS LINE

(Date)..............................

Commissioner,
Bureau of Reclamation,
Washington, D. C.

Sir: I am enclosing my check[1] (or money order) for $1.00 to pay for a year's subscription to The Reclamation Era.

Very truly yours,

September 1940.

(Name)..............................

(Address)..............................

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[1] Do not send stamps. Check or money order should be drawn to the Treasurer of the United States and forwarded to the Bureau of Reclamation.

Note.—36 cents postal charges should be added for foreign subscriptions.

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ADMINISTRATIVE ORGANIZATION OF THE BUREAU OF RECLAMATION

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Projects under construction or operated in whole or in part by the Bureau of Reclamation

Project	Office	Official in charge		Chief clerk	District counsel	
		Name	Title		Name	Address
All-American Canal	Yuma, Ariz	Leo J. Foster	Construction engineer	J. C. Thrailkill	R. J. Coffey	Los Angeles, Calif.
Altus	Altus, Okla	Russell S. Lieurance	Construction engineer	Edgar A. Peek	H. J. S. Devries	El Paso, Tex.
Belle Fourche	Newell, S. Dak	F. C. Youngblutt	Superintendent		W. J. Burke	Billings, Mont.
Boise	Boise, Idaho	R. J. Newell	Construction engineer	Robert B. Smith	B. E. Stoutemyer	Portland, Oreg.
Boulder Canyon [1]	Boulder City, Nev	Irving C. Harris	Director of power	Gail H. Baird	R. J. Coffey	Los Angeles, Calif.
Buffalo Rapids	Glendive, Mont	Paul A. Jones	Construction engineer	Edwin M. Bean	W. J. Burke	Billings, Mont.
Buford-Trenton	Williston, N. Dak	Parley R. Neeley	Resident engineer	Robert L. Newman	W. J. Burke	Billings, Mont.
Carlsbad	Carlsbad, N. Mex	L. E. Foster	Superintendent	E. W. Shepard	H. J. S. Devries	El Paso, Tex.
Central Valley	Sacramento, Calif	W. R. Young	Supervising engineer	E. R. Mills	R. J. Coffey	Los Angeles, Calif.
Shasta Dam	Redding, Calif	Ralph Lowry	Construction engineer		R. J. Coffey	Los Angeles, Ca
Friant division	Friant, Calif	R. B. Williams	Construction engineer		R. J. Coffey	Los Angeles, Ca
Delta division	Antioch, Calif	Oscar G. Boden	Construction engineer		R. J. Coffey	Los Angeles, Calif.
Colorado-Big Thompson	Estes Park, Colo	Porter J. Preston	Supervising engineer	C. M. Voyen	J. R. Alexander	Salt Lake City, Utah.
Colorado River	Austin, Tex	Ernest A. Moritz	Construction engineer	William F. Sha	H. J. S. Devries	El Paso, Tex.
Columbia Basin	Coulee Dam, Wash	F. A. Banks	Supervising engineer	C. B. Funk	B. E. Stoutemyer	Portland, Oreg.
Deschutes	Bend, Oreg	D. S. Stuver	Construction engineer	Noble O. Anderson	B. E. Stoutemyer	Portland, Oreg.
Gila	Yuma, Ariz	Leo J. Foster	Construction engineer	J. C. Thrailkill	R. J. Coffey	Los Angeles, Calif.
Grand Valley	Grand Junction, Colo	W. J. Chiesman	Superintendent	Emil T. Ficenec	J. R. Alexander	Salt Lake City, Utah.
Humboldt	Reno, Nev	Floyd M. Spencer	Construction engineer [2]		J. R. Alexander	Salt Lake City, Utah.
Kendrick	Casper, Wyo	Irvin J. Matthews	Construction engineer [2]	George W. Lyle	W. J. Burke	Billings, Mont.
Klamath	Klamath Falls, Oreg	B. E. Hayden	Superintendent	W. I. Tingley	B. E. Stoutemyer	Portland, Oreg.
Milk River	Malta, Mont	Harold W. Genger	Superintendent	E. E. Chabot	W. J. Burke	Billings, Mont.
Minidoka	Burley, Idaho	Stanley R. Marean	Superintendent	G. C. Patterson	B. E. Stoutemyer	Portland, Oreg.
Minidoka Power Plant	Rupert, Idaho	S. A. McWilliams	Resident engineer		B. E. Stoutemyer	Portland, Oreg.
Mirage Flats	Hemingford, Nebr	Denton J. Paul	Construction engineer		W. J. Burke	Billings, Mont.
Moon Lake	Provo, Utah	E. O. Larson	Construction engineer	Francis J. Farrell	J. R. Alexander	Salt Lake City, Utah.
North Platte	Guernsey, Wyo	C. F. Gleason	Superintendent of power	A. T. Stimpfig	W. J. Burke	Billings, Mont.
Ogden River	Provo, Utah	E. O. Larson	Construction engineer	Francis J. Farrell	J. R. Alexander	Salt Lake City, Utah.
Orland	Orland, Calif	D. L. Carmody	Superintendent	W. D. Funk	R. J. Coffey	Los Angeles, Calif.
Owyhee	Boise, Idaho	R. J. Newell	Construction engineer	Robert B. Smith	B. E. Stoutemyer	Portland, Oreg.
Parker Dam Power	Parker Dam, Calif	E. C. Koppen	Construction engineer	George B. Snow	R. J. Coffey	Los Angeles, Calif.
Pine River	Vallecito, Colo	Charles A. Burns	Construction engineer	Frank E. Gawn	J. R. Alexander	Salt Lake City, Utah.
Provo River	Provo, Utah	E. O. Larson	Construction engineer	Jos. P. Siebeneicher	J. R. Alexander	Salt Lake City, Utah.
Rapid Valley	Rapid City, S. Dak	Horace V. Hubbell	Construction engineer	Francis J. Farrell	W. J. Burke	Billings, Mont.
Rio Grande	El Paso, Tex	L. R. Fiock	Superintendent	H. H. Berryhill	H. J. S. Devries	El Paso, Tex.
Elephant Butte Power Plant	Elephant Butte, N. Mex	C. O. Dale	Acting resident engineer	H. H. Berryhill	H. J. S. Devries	El Paso, Tex.
Riverton	Riverton, Wyo	H. D. Comstock	Superintendent	C. B. Weatzel	W. J. Burke	Billings, Mont.
Shoshone	Powell, Wyo	L. J. Windle	Superintendent [2]	L. J. Windle [2]	W. J. Burke	Billings, Mont.
Heart Mountain division	Cody, Wyo	Walter F. Kemp	Construction engineer	L. J. Windle [2]	W. J. Burke	Billings, Mont.
Sun River	Fairfield, Mont	A. W. Walker	Superintendent		W. J. Burke	Billings, Mont.
Truckee River Storage	Reno, Nev	Floyd M. Spencer	Construction engineer [2]		J. R. Alexander	Salt Lake City, Utah.
Tucumcari	Tucumcari, N. Mex	Harold W. Mutch	Resident engineer	Charles L. Harris	H. J. S. Devries	El Paso, Tex.
Umatilla (McKay Dam)	Pendleton, Oreg	C. L. Tice	Reservoir superintendent		B. E. Stoutemyer	Portland, Oreg.
Uncompahgre: Repairs to canals	Montrose, Colo	Herman R. Elliott	Construction engineer [2]	Ewalt P. Anderson	J. R. Alexander	Salt Lake City, Utah.
Upper Snake River Storage [3]	Ashton, Idaho	I. Donald Jerman	Construction engineer [2]	Emmanuel V. Hillius	B. E. Stoutemyer	Portland, Oreg.
Vale	Vale, Oreg	C. C. Ketchum	Superintendent		B. E. Stoutemyer	Portland, Oreg.
Yakima	Yakima, Wash	J. S. Moore	Superintendent	Conrad J. Ralston	B. E. Stoutemyer	Portland, Oreg.
Roza division	Yakima, Wash	Charles E. Crownover	Construction engineer	Alex S. Harker	B. E. Stoutemyer	Portland, Oreg.
Yuma	Yuma, Ariz	C. B. Elliott	Superintendent	Jacob T. Davenport	R. J. Coffey	Los Angeles, Calif.

[1] Boulder Dam and Power Plant.

[2] Acting.

[3] Island Park and Grassy Lake Dams.

Projects or divisions of projects of Bureau of Reclamation operated by water users

Project	Organization	Office	Operating official		Secretary	
			Name	Title	Name	Address
Baker	Lower Powder River irrigation district	Baker, Oreg	A. Oliver	President	Marion Hewlett	Keating.
Bitter Root [4]	Bitter Root irrigation district	Hamilton, Mont	O. R. Walsh	Manager	Elsie W. Oliva	Hamilton.
Boise [1]	Board of Control	Boise, Idaho	Wm. H. Tuller	Project manager	L. P. Jensen	Boise.
Boise [1]	Black Canyon irrigation district	Notus, Idaho	Chas. W. Holmes	Superintendent	L. M. Watson	Notus.
Burnt River	Burnt River irrigation district	Huntington, Oreg	Edward Sullivan	President	Harold H. Hursh	Huntington.
Frenchtown	Frenchtown irrigation district	Frenchtown, Mont	Tom Sheffer	Superintendent	Ralph P. Scheffer	Huson.
Fruitgrowers Dam	Orchard City irrigation district	Austin, Colo	S. F. Newmen	Superintendent	A. W. Lanning	Austin.
Grand Valley, Orchard Mesa [3]	Orchard Mesa irrigation district	Grand Junction, Colo	Jack H. Naeve	Superintendent	C. J. McCormick	Grand Jctn.
Humboldt	Pershing County water conservation district	Lovelock, Nev	Roy F. Meffley	Superintendent	C. H. Jones	Lovelock.
Huntley [4]	Huntley Project irrigation district	Ballantine, Mont	E. E. Lewis	Manager	H. S. Elliott	Ballantine.
Hyrum [3]	South Cache W. U. A	Logan, Utah	H. Smith Richards	Superintendent	Herry C. Parker	Logan.
Klamath, Langell Valley [1]	Langell Valley irrigation district	Bonanza, Oreg	Chas. A. Revell	Manager	Chas. A. Revell	Bonanza.
Klamath, Horsefly [1]	Horsefly irrigation district	Bonanza, Oreg	Benson Dixon	President	Dorothy Eyers	Bonanza.
Lower Yellowstone [4]	Board of Control	Sidney, Mont	Axel Persson	Manager	Axel Persson	Sidney.
Milk River: Chinook division [4]	Alfalfa Valley irrigation district	Chinook, Mont	A. L. Benton	President	R. H. Clarkson	Chinook.
	Fort Belknap irrigation district	Chinook, Mont	H. B. Bonebright	President	L. V. Bogy	Chinook.
	Zurich irrigation district	Chinook, Mont	C. A. Watkins	President	H. M. Montgomery	Chinook.
	Harlem irrigation district	Harlem, Mont	Thos. M. Everett	President	R. L. Barton	Harlem.
	Paradise Valley irrigation district	Zurich, Mont	C. J. Wurth	President	J. F. Sharples	Zurich.
Minidoka: Gravity [1]	Minidoka irrigation district	Rupert, Idaho	Frank A. Ballard	Manager	O. W. Paul	Rupert.
Pumping	Burley irrigation district	Burley, Idaho	Hugh L. Crawford	Manager	Frank O. Redfield	Burley.
Gooding [1]	Amer. Falls Reserv. Dist. No. 2	Gooding, Idaho	S. T. Baer	Manager	Ida M. Johnson	Gooding.
Moon Lake	Moon Lake W. U. A	Roosevelt, Utah	H. J. Allred	President	Louie Galloway	Roosevelt.
Newlands [3]	Truckee-Carson irrigation district	Fallon, Nev	W. H. Wallace	Manager	H. W. Emery	Fallon.
North Platte: Interstate division [4]	Pathfinder irrigation district	Mitchell, Nebr	T. W. Parry	Manager	Flora K. Schroeder	Mitchell.
Fort Laramie division [4]	Gering-Fort Laramie irrigation district	Gering, Nebr	W. O. Fleenor	Superintendent	C. O. Klingman	Gering.
Fort Laramie division [4]	Goshen irrigation district	Torrington, Wyo	Floyd M. Roush	Superintendent	Mary E. Harrach	Torrington
Northport division [4]	Northport irrigation district	Northport, Nebr	Mark Iddings	Manager	Mabel J. Thompson	Bridgeport.
Ogden River	Ogden River W. U. A	Ogden, Utah	David A. Scott	Superintendent	Wm. P. Stephens	Ogden.
Okanogan [1]	Okanogan irrigation district	Okanogan, Wash	Nelson D. Thorp	Manager	Nelson D. Thorp	Okanogan.
Salt River [2]	Salt River Valley W. U. A	Phoenix, Ariz	H. J. Lawson	Superintendent	F. C. Henshaw	Phoenix.
Sanpete: Ephraim division	Ephraim Irrigation Co	Ephraim, Utah	Andrew Hansen	President	John K Olsen	Ephraim.
Spring City division	Horseshoe Irrigation Co	Spring City, Utah	Vivian Larson	President	James W. Blain	Spring City.
Shoshone: Garland division [4]	Shoshone irrigation district	Powell, Wyo	Paul Nelson	Irrigation superintendent	Harry Barrows	Powell.
Frannie division [4]	Deaver irrigation district	Deaver, Wyo	Floyd Lucas	Manager	R. J. Schwendiman	Deaver.
Stanfield	Stanfield irrigation district	Stanfield, Oreg	Leo F. Clark	Superintendent	F. A. Baker	Stanfield.
Strawberry Valley	Strawberry Water Users' Assn	Payson, Utah	S. W. Grotegut	President	E. G. Breese	Payson.
Sun River: Fort Shaw division [4]	Fort Shaw irrigation district	Fort Shaw, Mont	C. L. Bailey	Manager	C. L. Bailey	Fort Shaw.
Greenfields division	Greenfields irrigation district	Fairfield, Mont	A. W. Walker	Manager	H. P. Wangen	Fairfield.
Umatilla, East division [1]	Hermiston irrigation district	Hermiston, Oreg	E. D. Martin	Manager	Enos D. Martin	Hermiston.
West division [1]	West Extension irrigation district	Irrigon, Oreg	A. C. Houghton	Manager	A. C. Houghton	Irrigon.
Uncompahgre [3]	Uncompahgre Valley W. U. A	Montrose, Colo	Jesse R. Thompson	Manager	H. D. Galloway	Montrose.
Upper Snake River Storage	Fremont-Madison irrigation district	St. Anthony, Idaho	H. G. Fuller	President	John T. White	St. Anthony
Weber River	Weber River W. U. A	Ogden, Utah	D. D. Harris	Manager	D. D. Harris	Ogden.
Yakima, Kittitas division [1]	Kittitas reclamation district	Ellensburg, Wash	G. G. Hughes	Manager	G. L. Sterling	Ellensburg.

[1] B. E. Stoutemyer, district counsel, Portland, Oreg.

[2] R. J. Coffey, district counsel, Los Angeles, Calif.

[3] J. R. Alexander, district counsel, Salt Lake City, Utah.

[4] W. J. Burke, district counsel, Billings, Mont.

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SALLIE A. B. COE, *Editor*.

THE RECLAMATION ERA

OCTOBER 1940

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Secretary Ickes' Message to National Reclamation Association's Convention

Mr. O. S. Warden,
President, National Reclamation Association,
Great Falls, Mont.

My Dear Mr. Warden:

I regret that I cannot be in Great Falls during the period from September 24 to 26 this year to attend the ninth annual convention of the National Reclamation Association. I hope that you have a good meeting.

As in every year since 1932, Reclamation has continued this year to advance at an accelerated pace. It is a source of satisfaction to me to look back at the commencement and completion, since I, as Secretary of the Interior, first sent to the National Reclamation Association a note of greeting on the occasion of its convention in 1933, of such great dams as Seminoe, Alcova, and Bull Lake, in Wyoming; Taylor Park and Fruit Growers, in Colorado; Caballo and Alamogordo, in New Mexico; Bartlett, in Arizona; Parker and Imperial on the Colorado River; Rye Patch, in Nevada; Boca, in California; Agency Valley, Crane Prairie, and Unity, in Oregon; Grassy Lake and Island Park, in Idaho; Moon Lake, Hyrum, and Pine View, in Utah; and Fresno, in Montana. We have built more than a score of dams during these years. We have, as well, finished Boulder Dam and put it into service. We have seen magnificent Grand Coulee Dam rise from its foundation as millions of cubic yards of concrete have been placed until today it is at its full height of 550 feet for a large part of its length. It, too, soon will be in service. We have started other dams, now at varying stages of construction, such as Green Mountain and Vallecito, in Colorado; Deer Creek, in Utah; Friant and the Great Shasta, in California; Wickiup, in Oregon, and Marshall Ford, in Texas. Dams are, in one sense, but symbols of the fine work in the conservation of water and land resources which is done by the Bureau of Reclamation. They epitomize the irrigation water which has been controlled and made useful, the power which has been generated, and the homes and farms which have been established through this program.

It is a pleasure to me to see, not only this, but all phases of our broad conservation program make lasting gains. I count the quickening interest in conservation as a national policy among the great achievements of this national administration. I thank the National Reclamation Association for its fine efforts in this work, and I am confident that the work will continue.

Sincerely yours,

(Sgd.) Harold L. Ickes,
Secretary of the Interior.

PRICE
ONE
DOLLAR
A YEAR

THE RECLAMATION ERA

VOLUME 30 • OCTOBER 1940 • NUMBER 10

Convention of National Reclamation Association

THE ninth annual meeting of the National Reclamation Association was in session at Great Falls, Mont., September 24, 25, and 26. President O. S. Warden welcomed the delegates to his home town and presided at the meetings. Official addresses of welcome were delivered by Mayor Wuerthner of Great Falls, and Congressman James F. O'Connor of Montana. Other western groups meeting at Great Falls preceding this convention on September 22–23 were the Association of Western State Engineers, Mountain States Association of Chamber of Commerce Secretaries, and National Reclamation Association Directors; on September 23, Western Beet Growers Association and Western Governors Conference.

The Department of the Interior was represented at the meeting by Frederic L. Kirgis, who addressed the convention on the subject of The Relation of the Department of the Interior to Western Development. The Bureau of Reclamation was represented by a group from the Washington office headed by Commissioner Page whose address was on the subject of Reclamation in 1941 and 1942; his Secretary, Mary E. Gallagher; J. Kennard Cheadle, Chief Counsel; George O. Sanford, Chief, Operation and Maintenance Division, whose address was on the subject of The Reclamation Project Act of 1939; L. H. Mitchell, Irrigation Adviser, who treated the convention to an illustrated lecture on Saving Water in Transit; and W. E. Warne, Director of Information. A delegation of field officials was present headed by Chief Engineer Harper.

Governors Roy E. Ayers of Montana, Henry H. Blood of Utah, and Ralph L. Carr of Colorado; Senators O'Mahoney of Wyoming and Wheeler of Montana; Chief of Engineers of the Army Major General Schley; Public Works Administrator John M. Carmody; Representatives Chas. H. Leavy of Washington, Carl T. Curtis of Nebraska, James F. O'Connor of Montana, and Compton I. White of Idaho, were among the array of personages appearing on the elaborate program.

Messages by letter were sent to the convention by President Franklin Delano Roosevelt and Secretary of the Interior Harold L. Ickes.

Highlights of the Address of John C. Page

Commissioner, Bureau of Reclamation

WHAT lies ahead for Reclamation during the years 1941 and 1942?

We have here, on the one hand, a peace-time program geared to a long-range plan; a work looking toward increased security and added wealth. There, on the other hand, we have an intensive plan for complete defense, rapidly being geared to meet a national emergency; a work which is commanding stupendous efforts.

In the minds of all who are interested in the conservation of our natural resources and in the national defense is this question: Must the preparations for defense engulf the conservation programs?

Obviously, anything which is in conflict with the needs of defense must be shelved, and shelved now. It is equally clear that our conservation activities must not needlessly be disrupted, for in them will be found the strength of the sinews of the America of the future.

Part of the work in progress as a result of the Reclamation program is important directly and immediately to the national defense. I refer to the construction and equipping of power plants in connection with such dams as Boulder, Grand Coulee, Shasta, Seminoe, Green Mountain, Elephant Butte, and Parker. These are providing much and will provide more power for essential industries, such as the manufacture of airplanes, and the mining and smelting of metals and minerals.

An additional part of the work may be of importance in the comparatively near future. If defense needs should develop an urgent requirement for new sources of food supplies, as did happen once within the memory of every person in this room, the expansion by irrigation of cultivatable areas will assume real importance. This will be made possible by construction now in progress of irrigation works to serve such new land projects as the Yakima-Roza, the Boise-Payette, the Shoshone-Heart Mountain, the Gila, and the All-American Canal.

We must all understand that the demand for funds and men for defense will establish the priorities of work until our democracy, our liberties, and our way of life have been safeguarded. It seems inconceivable now that a crisis could develop which would demand cessation of the work we are doing.

As President Franklin D. Roosevelt said last May, and repeated just this month, "There is nothing in our present emergency to justify a retreat from any of our social objectives—conservation of resources, assistance to agriculture, better housing, and help to the underprivileged."

That the impact of migrations from the Great Plains has been felt most heavily in the far-Western States is shown by preliminary census figures for 1940. While the population of the United States as a whole in the past decade increased only 6.5 percent, the gain in the 11 Mountain and Pacific States was more than 13 percent.

In contrast to the experience of the dry-farm counties is the record of gains in population registered by counties in which Federal Reclamation projects are located. Almost without exception, these counties have continued their unbroken growth. Scottsbluff County in the heart of Nebraska's drought area may be cited as an example. Its population has increased 13 times since the North Platte project turned its range land into flourishing irrigated farms. With the completion of the Vale and Owyhee projects the number of persons in Malheur County, Oreg., increased in population by more than 8,500 in the past decade.

It takes time to plan and to build an irrigation system. The Federal Reclamation program cannot be expanded overnight to meet the impact of an urgent need, quickly arising.

Operation and Maintenance

Turning now to specific problems which will interest the members of the National Reclamation Association, the task of placing in operation the Reclamation Project Act of 1939 this year has given added emphasis all along the line to operation and maintenance activities. Much preliminary work has been done on revision of repayment contracts. Some requests for reclassification of land are being filled. We are now looking forward to a report from a special committee named by Secretary of the Interior Harold L. Ickes to investigate the repayment problems of certain project units as was contemplated by section 7 of the 1939 act. The Operation and Maintenance Division is now expanding its organization to increase the amount of assistance that can be given directly to the settlers, new and old.

As a result of one of the President's reorganization orders, a certain class of soil conservation work was transferred to the Department of the Interior. This transfer will make it possible for the Bureau of Reclamation to institute this year on its projects some work of this type. Studies are now in progress to design a program for the projects. We must of necessity start slowly along this new line. I believe that a sound beginning made this year may lead to major betterments and benefits in the future.

The maintenance of an even flow of repayments into the Reclamation fund is essential to the orderly completion of nearly a score of projects which are being financed from the fund. Even then the old problem of augmenting the fund continues a pressing one. About $200,000,000 will be needed altogether to complete these projects over a period of several years. Since accretions to the fund have been depleted by the virtual cessation of public land sales, the fund is now inadequate. It seems apparent that some time in the near future to meet a temporary situation it will be necessary either to advance money from the general treasury to the Reclamation fund or to shift the larger projects now being financed by appropriations from the Reclamation fund to the column of general fund appropriations. When the large projects such as Grand Coulee Dam and the Central Valley project begin their repayments, this situation should be considerably relieved. The repayment record has been satisfactory for the most part. Extensions have been granted under the provisions of the so-called Little Relief Act of 1939 for less than 20 percent of the amounts due on construction costs.

It is evident that because of the importance of Reclamation to the job of rehabilitating many now homeless and the emphasis the Congress has placed on this phase of our work, the Bureau of Reclamation must plan carefully the settlement and development of its project lands, and that it must continue the investigations of water and land resources by which potential future developments are blocked out. The first of what I feel will be a series of thorough studies for the planning of the development of project lands has been in progress this year. I refer to the joint investigations of the Columbia Basin irrigation project. More than 40 agencies, Federal, State, and local, are cooperating to determine the best methods for the development of the 1,200,000 acres which will be irrigated by Grand Coulee Dam. The investigations for preconstruction planning have continued at a satisfactory rate this year. It has been possible, as a result of larger appropriations in recent years, to place some of these preliminary investigations on a drainage basin basis, rather than on a project basis. This is an important advance, and I hope that funds may continue to be made available at rates which will permit the expansion of the practice to cover all of the West. Sound planning demands it.

I am sure all will be interested to know that we have been able by virtue of the preliminary investigations to obtain a more nearly accurate picture of the ultimate extent of western irrigation.

First, let me say that at present about 20,000,000 acres are irrigated, and that this area provides virtually all the opportunities for close settlement in rural areas which now exist west of the 100th meridian. We estimate that approximately 43,000,000 acres may be irrigated eventually. This total includes land now irrigated and about 2,500,000 acres which are within areas to be served by projects now under construction.

We are, in other words, approximately at the half-way point in the development of the West by irrigation in this year of our Lord 1940. One has but to see what has resulted from irrigation in the past to anticipate what is yet to come.

Excerpts from the Address of Frederic L. Kirgis

First Assistant Solicitor, Department of the Interior

THE Department of the Interior houses a family of agencies which are primarily concerned with the conservation of resources and with the development of the West.

Through the Land Office, the Geological Survey, the Bureau of Mines, the Indian Office, the National Park Service, the Fish and Wildlife Service, the Petroleum Conservation Division, the Grazing Service—to cite several examples—and through the Bureau of Reclamation, Interior is tied to the West as is no other Department of our Government.

The Department today is a far cry from the agency which was set up in 1849 to dispose of public land, yet from that agency it has grown. In its growth the Department has but kept pace, since gold rush days, as our country strode toward maturity. The growth reflects, as well, the increasing maturity of our thinking with respect to our national resources. The Department of the Interior has done its part and more in the long fight to oust exploitation and to place conservation as a national objective.

It is important to the West that the Department of the Interior keep on the move with eyes front. I feel that it is important to the Department of the Interior that such groups as the National Reclamation Association act as guidon bearers to keep the whole western parade in formation.

The reclamation act was signed on June 17, 1902. The Bureau of Reclamation still operates under that act, but the law has been much modified, amended, and elaborated. And this is as it should be. Could anyone who might have been standing at the elbow of Theodore Roosevelt in the White

House that June day 38 years ago have foreseen the control of the Columbia River by Grand Coulee Dam and could anyone have provided for it then? The electric age had not fuly dawned in 1902 and Grand Coulee Dam is feasible only because of its hydroelectric power. Could anyone then have foreseen the Central Valley project in California? Development in the basins of the Sacramento and the San Joaquin Rivers was in its infancy at that time and the pumps had not been designed which since have lowered the water tables and made necessary the geographical reapportionment of the waters of central California. Could anyone in 1902 have visualized the Colorado-Big Thompson project with a 13-mile tunnel through the Continental Divide? Perhaps vaguely one could, as might have Jules Verne, but the engineers were not ready to undertake so long a tunnel in those days. Could anyone four decades ago have outlined the plan adopted recently for the reclamation-relief projects now being started in the northern Great Plains States?

If the reclamation law had not been a dynamic, a forward-moving thing during these 38 years; if it had not been able to meet, through extensions and modifications, the needs of the progressing times, it undoubtedly would have been laid away on a shelf long since.

Reclamation has reset its sights from time to time while holding the fundamental thought that it must provide opportunities for new homes and that it must develop the West. If it ever should cease to do so, if you of the West ever permit reclamation to cease to reset its sights from time to time, then I fear the march of reclamation will be nearly done.

Relief and Reclamation

In recent years the drought and the migrations of indigent people for which the drought in part has been responsible have operated powerfully to broaden the reclamation program. These pointed out the need for utilization of little rivers for the watering of small areas to be used in resettling and stabilizing stricken communities. Heavy relief loads of necessity were being carried in the areas which needed such opportunities most. Generally for these small areas the cost per acre of the irrigation systems exceeded the amount which the water users could be expected to repay. What could be more logical than to join relief and reclamation programs to provide a type of irrigation project not wholly reimbursable? This was done, and now the prospect is for gradual readjustments of permanent value in the land use of many drought-stricken sections, with attendant and very real gains for the thousands of families who are involved. It is good thus to provide ways for men to work out futures for themselves.

Prominent also among the influences is hydroelectric power, which has made economically feasible great projects through the teaming of turbines with irrigation works. Power has become a mighty ally of the irrigation canal in the development of the West. It has made possible Boulder Dam, Grand Coulee Dam, the Central Valley project, the Kendrick project in Wyoming, the Colorado-Big Thompson project, and power holds the promise of assistance in many other areas. There must, however, be something reciprocal in the relationship of allies, and this vital something in the relationship with power should not be overlooked by western irrigation leaders. There must be no intent to subjugate power to irrigation, for power is too strong to be shackled.

I mean that hydroelectric power can and should be used to bring widespread public benefits comparable in some ways with those which are obtained from irrigation. If it is right to seek wide public benefits through irrigation then it is right to seek similarly wide public benefits from the hydroelectric power which is developed in conjunction with irrigation. Any plan for the combination of irrigation and power which overlooks the public services that may be rendered by either has in it a weakness potentially fatal.

Along all the roads on which the agencies of the Department of the Interior move are the mileposts which mark advances in the development of the West and of the Nation as a whole. It is recognized that the relationship of the Department to the development of the West is one that is close and intimate; one that imposes a responsibility on both the officials of the Department and the leaders in these Western States to see that the programs administered by the agencies of the Department are guided by the public interest toward a bright future.

Know Your Northwest Series

THE Northwest Regional Council has just issued three booklets of the following titles:

1. Soil Conservation in Outline.
2. Forest Depletion in Outline.
3. Pacific Northwest Resources in Outline.

This is an educational series and others will follow. The purpose is to present in nontechnical language facts on the subjects featured which make them adaptable to classroom presentation. The material is derived from a wide variety of published sources and field observation and as presented suggests other sources of information for those seeking educational material. They may also serve as a guide to teachers in setting up study units. They are definitely not textbooks but the student will find them helpful in reaching a fair understanding of the fundamentals of each subject.

Copies may be secured by addressing the Northwest Regional Council, Portland, Oreg. They are priced at 25 cents each.

The objectives of the Northwest Regional Council are as follows:

1. To stimulate a greater public awareness of the basic problems of the Pacific Northwest.
2. To make available at all educational levels accurate and stimulating materials concerning the social, economic, and governmental problems of the region.
3. To provide the machinery for conference and consultation among the advisory, research, planning, and educational agencies concerned with the orderly development of the Pacific Northwest.
4. To foster coordinated research in the natural and human resource fields so that wasteful duplication may be avoided and new fields for constructive research may become more clearly defined.
5. To act as a clearing house for the interchange of bibliographic and other technical data of regional significance.
6. To make known the training required and opportunities available for career service in the various agencies of Federal, State, and local government. To encourage the extension of sound public service training facilities.
7. To assist by means of publication and grants-in-aid specific research of a highly significant character and primarily regional in scope.—*M. A. S.*

Mexican Officials, Visitors

GUSTAVO P. SERRANO, Water Commissioner of the International Boundary Commission, United States and Mexico, and Sanchez Gavito, an official of the Mexican Claims Commission, called to pay their respects at the Washington office of the Bureau of Reclamation during September. They were on an automobile tour which took them from Washington to Knoxville, Tenn., where they viewed the dams of the Tennessee Valley Authority.

Mr. Serrano was a former associate of American members of the International Water Commission, United States and Mexico, of which the late Dr. Elwood Mead was chairman of the American section, and Mr. Serrano chairman of the Mexican section. The Commission's study, extending over a period of 5 years, was concluded with a report to Congress which was printed as House Document No. 359, Seventy-first Congress, second session.

Airports Serving Federal Reclamation Projects

By MAE A. SCHNURR, *Chief, Public Relations Division*

A SURVEY of airports and facilities serving project territory reveals the fact that we have benefited in improved transportation facilities by America's progress in the aeronautical arts and sciences. Many of these airbases have been inaugurated or enlarged and improved by Government agencies such as the Work Projects Administration, the National Park Service, and the Civilian Conservation Corps.

The Civil Aeronautics Authority conducted a national survey of airports and in a report to Congress made recommendations relative to the desirability of Federal participation in the construction, improvement, development, operation, and maintenance of a national system of airports, and to the nature and extent of such participation. Its report was printed as House Document 245, Seventy-sixth Congress, first session. It shows 1907 existing civil airports (excluding intermediate fields and seaplane bases) as of January 1, 1939.

Serving projects of the Bureau of Reclamation are 36 airports. These range from flying fields with modern equipment, servicing facilities, and hangars, to "postage stamp" landing fields and are located on project areas, in towns on projects, or in cities short distances from projects. A review of these follows:

Belle Fourche project, South Dakota, has a field to accommodate small planes only.

Boise project, Idaho.—This project's airfield is on a federally lighted transcontinental airway.

In addition to the Boise Municipal Airport, two Boise project cities have municipal airports, Nampa and Caldwell, both surrounded by land irrigated under the project. Further development of these fields is being sponsored under the progressive program of the State Aeronautics Division.

During the winter when all highway transportation in the mountains is blocked by heavy snows, regular airplane service is maintained to a number of mining camps in central Idaho and to Deadwood Reservoir. This reservoir is located about 55 miles northeast of Boise in rugged mountain country and furnishes storage for the Black Canyon power plant on the Payette River near Emmett. Airplanes carrying mail, supplies, and passengers are equipped with skis and make landings on the ice or in a cleared area at the upper end of the reservoir.

Boulder Canyon project, Arizona-Nevada.—The Boulder City Airport was completed by C. C. C. enrollees under the direction of the National Park Service.

The National Park Service issued an exclusive permit to the Grand Canyon-Boulder Dam Tours, Inc., for the operation of the field. This permittee, with the inauguration of air mail and passenger service in and out of Boulder City on April 3, 1938, leased the field to T. W. A.

In addition to the service by T. W. A., the Grand Canyon-Boulder Dam Tours, Inc., has planes available for trips over the area around the dam, and charter trips to Death Valley, Grand Canyon, Pierce Ferry, and any points in the United States where practical landing is possible.

Also within the project's area is a very spectacular field at Pierce Ferry near the shore of Lake Mead. This field is situated on a bluff and is known as the field where one flies up to land.

Carlsbad project, New Mexico.—This project is served by an airport approximately 160 acres in extent, located about 2 miles south of the town of Carlsbad, which is situated on the project.

Columbia Basin project (Grand Coulee Dam), Washington.—An airport, located on a bench on the east side of Columbia River, about a mile below the dam, was built as an unemployment emergency project in the winter of 1933–34 by the Washington E. R. A., under the supervision of Okanogan County Commissioners and the National Guard. During the tourist season, planes are available for short sightseeing trips up and down the Columbia and over the works area.

Frenchtown project, Montana.—Headquarters for this project is located at Missoula, 17 miles distant, where there is a municipally owned airport, all-weather field and equipped for night service.

Grand Valley project, Colorado.—The municipal airport is situated 3 miles north of the city limits of Grand Junction on a tract of 242 acres. Local sightseeing planes are regularly housed at the field.

Kendrick project, Wyoming.—Wardwell field lies 5 miles north of the city of Casper, Wyo., headquarters for the Bureau of Reclamation on the Kendrick project. Inland Air Lines Incorporated operates the field. A Government installed marker atop the Wyoming National Bank building in downtown Casper indicates the landing field location. Beacons light the way from Cheyenne to Billings.

Klamath project, Oregon-California.—The airport is located 5 miles southeast of the city of Klamath Falls and is owned by the city. It is reached by a paved highway and occupies an area of 320 acres.

Milk River project, Montana.—Airports at Glasgow and Havre serve this project. The Glasgow field is 1 mile from the center of the city. The Havre Municipal Airport, covering 160 acres, is located 4 miles from the center of the city.

Minidoka project, Idaho.—The Burley Municipal Airport is situated adjacent to the east boundary of Burley. W. P. A. forces have assisted materially in improvement of the field.

Ogden River project, Utah.—The Ogden Municipal Airport, which is located 3.3 miles south of the center of the business section of Ogden City, has been leased from the Ogden Land Co. for a period of years.

Orland project, California.—The airport at Willows, 16 miles south of Orland, serves this project. It is supported jointly by the town of Willows and the county of Glenn, covers 160 acres, is an all-weather flying field, and is equipped for night flying.

Agriculture is served in the form of airplane seeding. Portions of the southern end of Glenn County and the north end of Colusa County are well adapted to the growing of rice and a large acreage has been devoted to the raising of this crop for some years past. Due to the late spring rains, which prevail every year, the lands are seldom dry enough at seeding time to allow this work to be done with machines so that in many cases in the past it was late in the season before operations could be started. Some inventive genius conceived the idea of broadcasting rice seed from a plane and a venturesome pilot was found who was willing to demonstrate his prowess as an aid to agriculture.

TITLES TO PHOTOS OPPOSITE

1. Phoenix, Ariz. (Salt River project)
2. Grand Coulee Dam (Columbia Basin project)
3. Fly Field, Yuma, Ariz.
4. Salt Lake City, Utah
5. Boise, Idaho
6. Hangar on Fly Field, Yuma
7. El Paso, Tex. (Rio Grande project)
8. Radio towers at airport, Burley, Idaho (Minidoka project)
9. Burley, Idaho
10. Concrete marker at center of airport, Burley, Idaho
11. Missoula, Mont., airport
12. Biggs Field, U. S. Army, El Paso, Tex.
13. Boulder City Airport, Nevada
14. River Ferry Airport, Nevada
15. Casper Airport, Kendrick project, Wyoming
16. Phoenix Municipal Airport, Arizona

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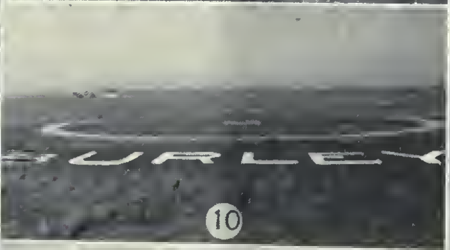

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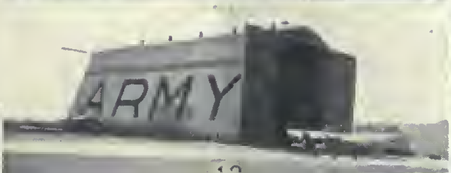

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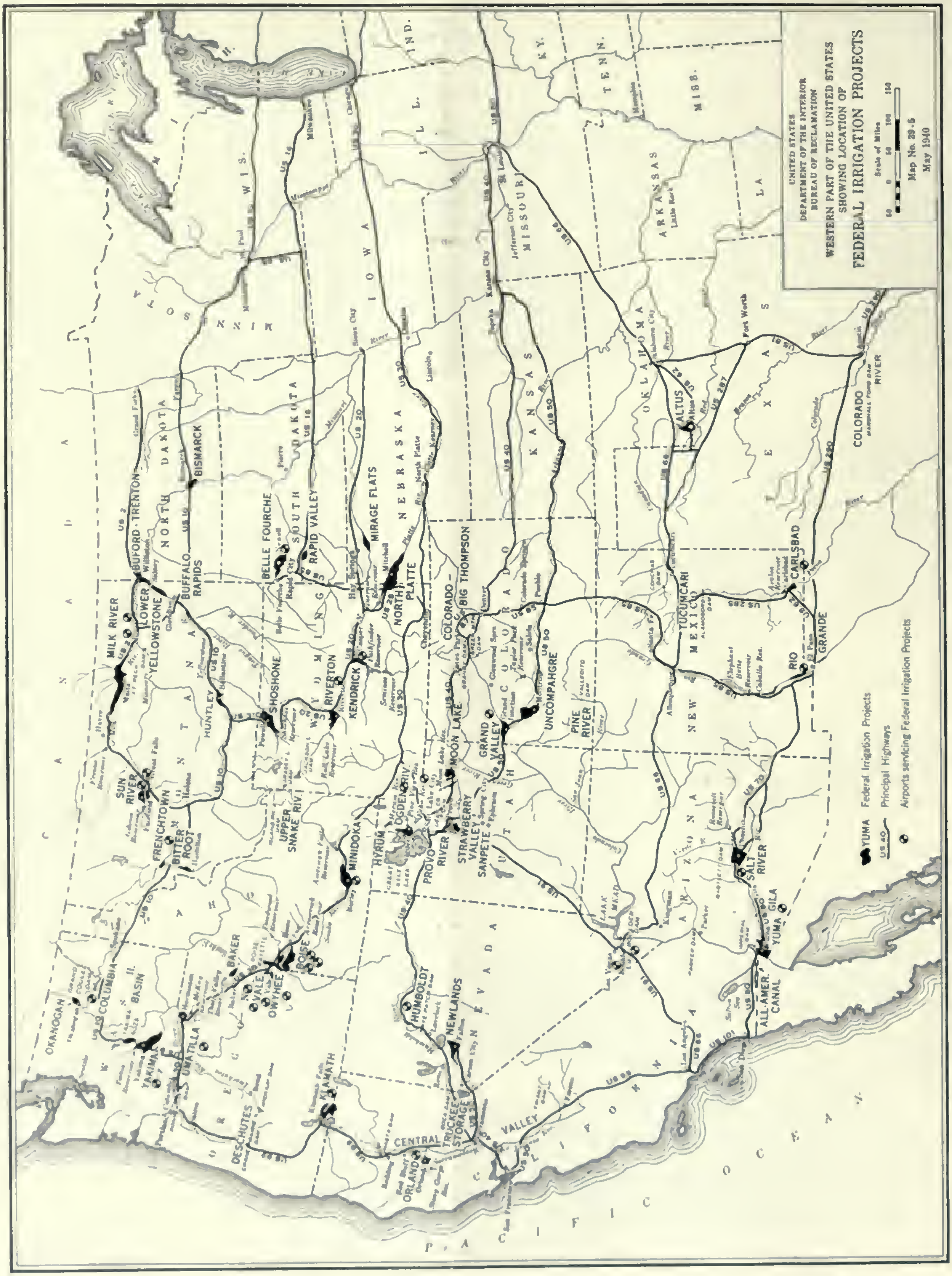
UNITED STATES
DEPARTMENT OF THE INTERIOR
BUREAU OF RECLAMATION
WESTERN PART OF THE UNITED STATES
SHOWING LOCATION OF
FEDERAL IRRIGATION PROJECTS
Scale of Miles
50 0 50 100 150
Map No. 39-5
May 1940
YUMA Federal Irrigation Projects
US 40 Principal Highways
Airports servicing Federal Irrigation Projects
OKANOGAN
COLUMBIA BASIN
YAKIMA
UMATILLA
DESCHUTES
KLAMATH
ORLAND
CENTRAL VALLEY
TRUCKEE STORAGE
NEWLANDS
HUMBOLDT
BAKER
VALE
OWYHEE
BOISE
MINIDOKA
UPPER SNAKE RIV.
BITTER ROOT
FRENCHTOWN
SUN RIVER
MILK RIVER
LOWER YELLOWSTONE
BUFORD-TRENTON
BUFFALO RAPIDS
BISMARCK
HUNTLEY
SHOSHONE
RIVERTON
KENDRICK
NORTH PLATTE
MIRAGE FLATS
RAPID VALLEY
BELLE FOURCHE
COLORADO-BIG THOMPSON
MOON LAKE
GRAND VALLEY
UNCOMPAHGRE
PINE RIVER
HYRUM
OGDEN RIV.
PROVO RIVER
STRAWBERRY VALLEY
SANPETE
SALT RIVER
GILA
YUMA
ALL-AMER. CANAL
RIO GRANDE
TUCUMCARI
CARLSBAD
ALTUS
COLORADO RIVER
PACIFIC OCEAN
CANADA

From that idea have developed the practices which are yearly demonstrating their effectiveness and economy. At the present time small planes are used for the work. The plane is equipped with a hopper located just forward of the pilot's seat and just back of the plane's propeller. In the bottom of the hopper is a sliding gate which can be controlled by the pilot. Seed going through the gate drops on a pan which is divided into flaring channels by vertical partitions. Both ends of the pan are open and one end is just behind the propeller. The air stream from the propeller passes through the flaring channels of the pan and carries with it the seed which leaves the plane in a comparatively uniform manner. It is said the stands of rice secured through this manner of seeding are far more uniform than those to be had by seeding in the conventional manner. It is the practice to seed with the ground covered with water to a depth of 5 or 6 inches, and since the rice seed is heavy it at once sinks below the water surface and is hidden from the birds which always make inroads on dry seedings.

In the seeding operations, the field to be sowed is marked off into strips by placing flags across the two ends designating the widths of the strips to be covered by one passing of the plane. The planes fly at a speed of approximately 100 miles per hour and at a height of 30 feet above the ground.

Owyhee project, Oregon-Idaho.—At present the Owyhee project has only one improved airport, the municipal field at Ontario, Oreg., which has been developed by the city and Work Projects Administration. This field also serves as a Department of Commerce intermediate field. Just to the west of the airport stretches the bright aluminum-painted Malheur River Siphon, a 4½-mile steel pipe line carrying water from the main North Canal of the Owyhee project to the Dead Ox Flat division. This provides an excellent landmark even when visibility is poor.

Provo River-Sanpete projects, Utah.—The Salt Lake Municipal Airport serves these projects. It is an important transcontinental field located 4 miles west of the business district of Salt Lake City. It has an attractive group of administration buildings and at the edge of the field are seven hangars owned by Salt Lake City, the individual transport companies, the Army, and the Thompson Flying School. Its location makes it the hub of aviation transportation and communication in the Western States. Situated in the natural center of intermountain industry and western scenic America, it affords an excellent point of dispatch for passenger, air mail, and express service. The Bureau of Reclamation projects in Utah are well served by this airport as it can be reached from the most distant project within 3 hours by automobile.

Two of the runways constructed through a W. P. A. project are claimed to be among the longest paved runways in the world. The north-south and the northwest-southeast runways are each 5,500 feet long and 150 feet wide. The east-west runway is 4,000 feet long and 150 feet wide. Salt Lake City's airport represents an investment of approximately $2,000,000, and is listed as one of the outstanding airports in the United States.

Rio Grande project, New Mexico-Texas.—The El Paso Municipal Airport serves this project. In addition to the municipal airport, the United States Army also maintains Biggs Field Airport at Fort Bliss, which is increasing in size and importance as the aviation branch of our military force expands.

Riverton project, Wyoming.—The Keating Airport, which serves this project, is located on a section of land about midway between the town of Riverton and the first project lands to the west.

Salt River project, Arizona.—The municipally owned airport at Phoenix, Ariz., known locally as Sky Harbor, is officially rated as a transport airport and is considered to be one of the finest of its kind in the Southwest.

Sun River project, Montana.—An airport at Great Falls, Mont., 35 miles southeast of the project, and one at Choteau, 19 miles northwest, serve this project.

Truckee River Storage and Humboldt projects, Nevada.—This airport is located 4½ miles southeast of Reno, Nev., about 1½ miles east of the Reno-Carson City Highway.

Umatilla project, Oregon.—The Pendleton Airport owned by the city serves this project and is situated about 3 miles northwest of Pendleton.

Vale project, Oregon.—The Vale project airport, located approximately 1 mile south of the city of Vale, will accommodate the landing and taking off of large cabin planes. There is another airport lying between Vale and Ontario near the latter city.

Yakima project, Washington.—The Yakima project has airport facilities at Yakima, Ellensburg, Easton, Sunnyside, Prosser, Cle Elum, and Toppenish.

The Yakima Municipal airport is 3 miles southwest of the city center of Yakima and is reached by a concrete highway.

Twenty-five miles to the north is the Ellensburg Airport, which is located about 2 miles from the city center of Ellensburg and is reached by hard-surfaced roads.

The Cle Elum Airport is located about 2 miles from Cle Elum, on a graveled road.

The Easton Airport is an emergency landing field and can be used only during the summer, except in extreme emergencies. It is located 1½ miles from Easton, near the concrete State highway.

Prosser, Sunnyside, and Toppenish have airports which can be used only for daylight emergency landings. The Prosser and Sunnyside Fields are of sufficient size to accommodate transport planes.

Yuma project, Arizona.—Fly Field, the local aviation field, is located 4½ miles south of Yuma, Ariz., on the Yuma Mesa with United States Highway No. 80 bounding it on the north. The field derives its name from the late Col. B. F. Fly of Yuma Mesa fame, who for many years was actively engaged in advancing the interests of the Yuma project in Washington.

Reports on project airports indicate a lively interest in enlargement and improvement of airport facilities on the basis of increased demand for service; therefore, as this account goes to press it might not reflect the enlarged picture, but at least the story, as here presented, shows reclamation territory has created a demand and contributed considerably to the popularity of traveling by air.

National Defense Arouses Interest

Four bills were introduced in the present session of Congress, S. 3620 and S. 4146 by Senator McCarran of Nevada, H. R. 9049 by Representative Houston of Kansas, and H. R. 10067 by Representative Lea of California. These bills, among other things, propose Federal cooperation with the States in the development of aircraft, landing areas adequate to provide for the national defense, the postal service, and civil aeronautics.

H. J. Res. 554, introduced by Representative Dingell of Michigan, proposes an appropriation of $50,000,000 for improvement of existing airports.

None of these measures has been enacted into law up to the writing of this article (September 11). Hearings were held on Senator McCarran's bill S. 3620 last May, subsequent to which the Senator introduced his second bill, S. 4146.

H. R. 10539, the supplemental appropriation bill for civil functions of the Government, is before the President for signature as this issue goes to press (October 9). It contains an item of $40,000,000 for the construction of new airports and improvements of existing ones for national defense purposes.

With the Federal and State governments aroused, continued activity in building new airports and improving existing ones may be expected.

TITLES TO PHOTOS ON PAGE 284

1. Rio Grande Municipal Airport, El Paso, Tex.
2. Yakima Airport, Yakima, Wash.
3. Eastbound Mainliner, Truckee River storage project, Nevada. All aboard!
4. Mainliner coming in for refueling, Truckee River storage
5. Main Building, United Airport, Truckee River storage
6. Boulder City Airport building, Nevada
7. Airview, Grand Junction Municipal Airport, Grand Valley project, Colorado
8. Fly Field, Yuma, Ariz.
9. Salt Lake Airport, Utah
10. Glasgow, Mont.

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Central Valley Milestones

FOUR milestones of progress on the Central Valley project were passed in the month of July 1940, marking significant developments in the construction of this multiple-purpose reclamation project in California.

On July 8 at 10:02 a. m. the first concrete was placed in Shasta Dam on the upper Sacramento River near Redding.

The same day, 6 minutes later and 200 miles away, the first test pumping of water on the project took place on the Contra Costa Canal near Oakley.

On July 29 at 2:02 p. m. the first concrete was placed in Friant Dam on the upper San Joaquin River near Fresno.

Almost simultaneously the same day the San Joaquin River was diverted at the Friant Dam site into a temporary channel cut along the south bank.

First Concrete Placed in Shasta Dam

The "birth" of Shasta Dam, which will be the second largest concrete structure in the world, was witnessed by about 400 persons gathered on the east abutment. The first 8-yard batch of concrete, mixed in a 5-unit plant located alongside the cableway head tower on the west side of the canyon, was brought out on the "Goose," which is the name for one of the electric railway cars operating on an endless quarter-mile track which circles the head tower from the mixing plant out to a loading dock.

The crowd cheered as the bucket of concrete was picked up by cableway No. 2 and carried out over the canyon on the half-mile long high line at a speed of 1,700 feet a minute. The cableway carriage stopped when it reached a point over the east bank of the river. The big bucket was lowered into place behind the forms for Block 38–C near the base of the dam. A signalman, speaking into a microphone of a short-wave radio-communication system, gave the word to a cable operator in the head tower, and the first of 6,000,000 cubic yards of concrete to go into Shasta Dam and power plant in the next 3 or 4 years, was deposited onto the cleaned bedrock.

Preparatory to concrete placement, about 4,000,000 cubic yards of earth and rock had been excavated from the dam site since work was started in September 1938. About 250,000 yards remain to be excavated. Trainloads of cement were shipped in from the specially-built cement manufacturing plant near San Jose, and thousands of tons of sand and gravel were delivered from Redding via the 10-mile belt conveyor system which extends over the hills between the aggregate processing plant and the dam site.

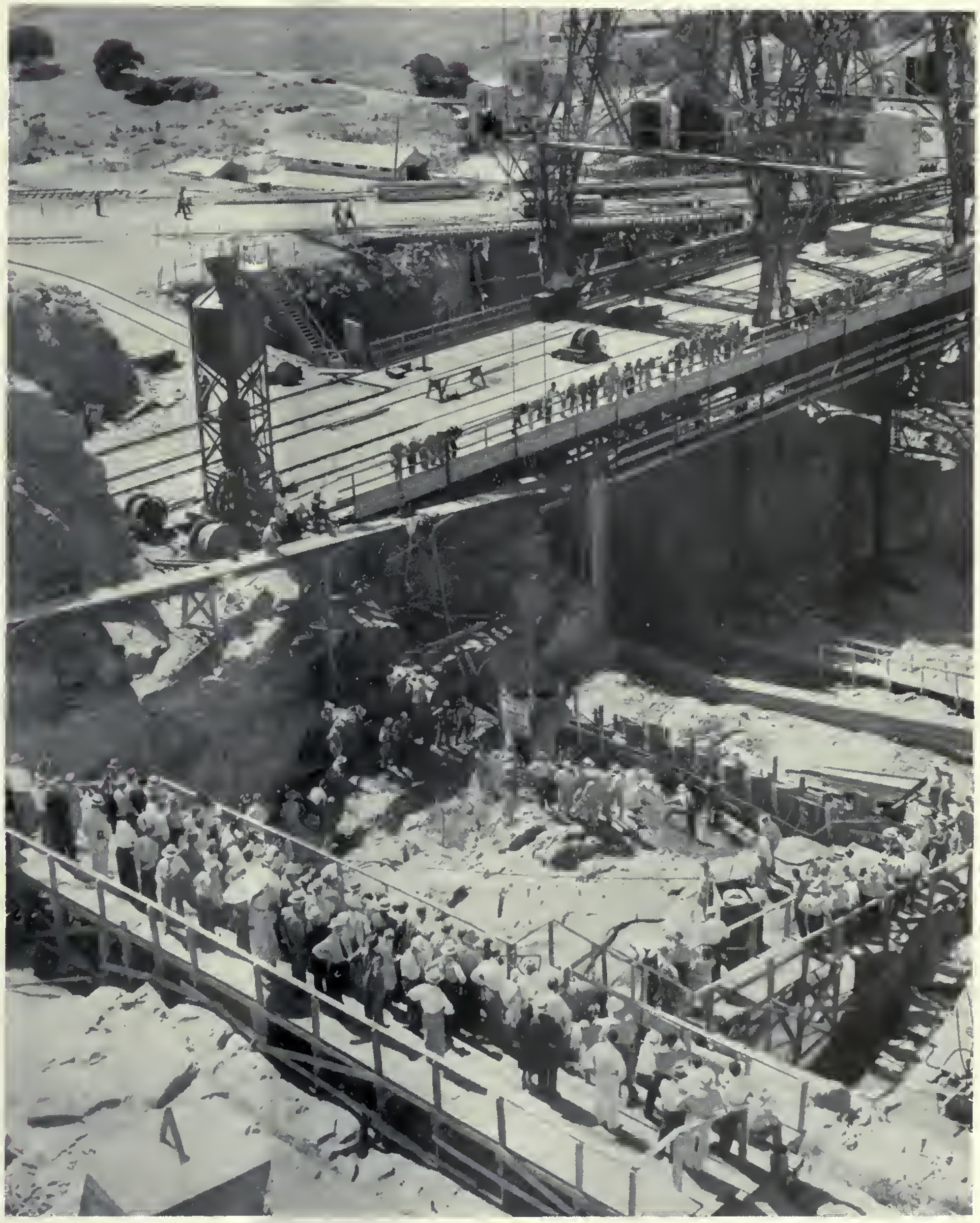
Shasta Dam is being constructed by the cableway system with seven high lines radiating from the top of the 460-foot high head tower to seven smaller movable tail towers which travel on curved runway tracks at various parts of the dam site, thereby providing complete bucket coverage of both abutments, the central spillway section, and the powerhouse area.

Work on Contra Costa Canal

In preparation for use of a portion of the Contra Costa Canal starting this fall, the test pumping of water began at pumping plant No. 1. Supervising Engineer Walker R. Young threw a switch that started a motor for one of the pump units and the first water flowed into the concrete-lined canal from a tidewater section of the ditch which extends from Rock Slough near Stockton.

Except for the headworks, the first 20 miles of the Contra Costa Canal are completed from the Rock Slough intake to a point 3 miles west of Pittsburg. Arrangements have been made between the Bureau of Reclamation and the Contra Costa County Water District for use of this portion of the canal on an interim basis to serve the city of Pittsburg and the

Crowd cheers placing of first concrete in Friant Dam



Columbia Steel Co. with such water as may be available in Rock Slough. Pittsburg's municipal water system, including a modern treating plant recently completed, is connected to the canal by a 24-inch pipe line. Inasmuch as the canal's regular water supply is to come from Shasta Reservoir under eventual operation of the Central Valley project, the canal cannot be placed in normal operation until completion of Shasta Dam scheduled early in 1944.

Friant Dam Receives First Concrete

At Friant Dam, where a virtual "forest" of cranes and derricks marks the sky line, the first 4 yards of concrete was dumped in block 17 high on the south abutment. About 1,000 persons witnessed the event, some of them accommodated on special bleachers erected on the bedrock just above block 17. The work was explained to the crowd over a public address system. The initial concrete, mixed in a 4-unit plant located on the south side of the canyon, was brought out on a Diesel-electric train and the bucket was swung into place by a big stiff-leg derrick. A number of shallow blocks at the Fresno County end of the dam will be placed before concrete work begins at the base of the structure.

Most of the 2,200,000 cubic yards of concrete to go into Friant Dam will be placed by four cranes traveling on a 2,200-foot structural steel trestle being constructed across the canyon. Two hammerhead cranes with 300-foot arms and a whirley crane with a 125-foot boom have been erected on the trestle. Another whirley has been set up temporarily on tracks laid along a bench at the top of the south abutment to handle the concrete in blocks 8 to 17. Two 180-foot derricks complete the lay-out.

San Joaquin River Diverted

Although initial concrete placement was not contingent upon river diversion, coincidentally the task of turning the San Joaquin River aside began early the same morning when the flow was cut down to about 400 second-feet at the Kerckhoff power plant up in the mountains. Actual diversion was effected by driving steel piling into the stream bed at a 25-foot opening which had been left in the upstream cofferdam. Water began to flow through the 1,700-foot long diversion channel about 2:15 p. m., almost unnoticed by the crowd intently watching the concrete placing up on the south abutment. The channel, having a designed capacity of 10,000 second-feet, crosses the dam site excavation on a 250-foot-long wooden flume. With more than 1,000,000 cubic yards of earth and rock removed to date to provide a permanent anchorage for the dam, the excavation is being extended to the natural river-bed area where concrete placement will begin later this fall.

The first steps are accomplished on Friant Dam which is scheduled for completion in February 1943.

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Marshall Ford Dam Starts Work

MARSHALL FORD DAM, under construction by the Bureau of Reclamation 12 miles northwest of Austin, Tex., is the chief structure of the Colorado River flood control project, and will be the fifth largest concrete dam in the world.

The dam, which will have 1,864,000 cubic yards of concrete, will be 270 feet high and 2,623 feet long at the crest. A rock-faced earth embankment 105 feet high and 2,500 feet long will wing off the south end of the dam, making it nearly a mile overall.

Three penstocks for power development are being installed. The Lower Colorado River Authority is building the power plant, which will have a capacity of 67,500 kilowatts capable of an annual output of 136,000,000 kilowatt hours of firm energy and 101,000,000 of secondary energy.

The principal purpose of the dam is to control Colorado River floods which average more than $4,000,000 a year in property damage. Its cost is placed at $24,991,000. The President recently transmitted to Congress his approval of a budget estimate for $2,500,000 in construction funds. It is expected this sum will be enough to finish the dam, which is now about 200 feet above foundation.

Construction of the dam was begun in March 1937, and is scheduled for completion about the end of next year. Early plans called for a 190-foot high dam, but the flood of 1938 demonstrated the need for a higher structure to more effectively control the river.

The dam will help to control floods and generate hydroelectric energy and in addition will regulate the Colorado so as to provide a steady supply of water for irrigation to rice farmers on lands below.

The reservoir to be created by the dam will have a capacity of 3,120,000 acre-feet or about 1 trillion gallons of water. The generating equipment is to consist of 3 units of 22,500 kilowatts each.

Commissioner Page in his report to Secretary of the Interior Ickes, said:

"The diversion conduits have now been sealed off and the dam is beginning to impound water. This is the start of controlled storage in the Marshall Ford Reservoir. When completed, Marshall Ford Dam will provide a substantial measure of flood control on the Colorado, a particularly dangerous stream, subject to quick floods of great heights."

Colonel Alexander McD. Brooks Dies

COLONEL BROOKS, purchasing agent for the Bureau of Reclamation in the Denver office, retired from active service on March 31, 1938. His photograph and a notice of his retirement were carried in the February 1938 issue of the RECLAMATION ERA. He died at his home in San Diego, Calif., of a heart attack on September 21, 1940.

Surviving Colonel Brooks are his wife, Mary Ringold Brooks, and four sisters, Mrs. Jack Harrison, Mrs. Margaret Dickson, Miss May Brooks, and Miss Madeleine Brooks, all of Denver.

Colonel Brooks' legion of friends throughout the Bureau of Reclamation mourn the loss of this friend and extend to his family heartfelt sympathy in their bereavement.

Temperature Control of Concrete Mixing Water in the Imperial Valley

By J. R. LAWRENCE, *Engineer, All-American Canal Project*

IMPERIAL VALLEY in southern California is well known to most people for the high atmospheric temperatures that prevail during the summer months. During the past few years, considerable construction work, involving the placing of concrete, has been in progress on the All-American Canal and the Coachella Branch of the All-American Canal system.

The high degrees to which temperatures rise, in the vicinity of this work, during the summer months make it necessary that the placing of concrete on all Bureau of Reclamation work in Imperial Valley be limited to the months of October to May, inclusive, in order to meet the requirement that the temperature of concrete during the placing season shall not be allowed to exceed 90° F. Even during the months of April, May, and October, which are within the concrete placing season, it is sometimes difficult to comply with this requirement.

In April and May of 1939, the problem of controlling the temperature of concrete-mixing water for structures on the Coachella Branch of the All-American Canal became especially acute. This section of the canal is located through desert country, making it necessary to transport water by pipe lines from the nearest source to the sites of the various structures along the canal.

Water is first pumped a distance of 7,500 feet from the nearest irrigation lateral to a point on the Coachella Canal where it is stored in tanks or natural reservoirs. From these reservoirs, the water is pumped through a second pipe line, running parallel to the canal, to the structure sites. Four-inch diameter pipes are used. The maximum length of pipe line through which the water travels from its source to the most distant structure is 11 miles. The pipe line throughout this entire distance lies on the surface of the ground and is exposed to the rays of the sun. With this method of transporting water, it became impossible, even during the first part of April, to keep concrete temperatures below 90° F. during the day.

Water-cooling Tower Constructed

Thus it became necessary at the beginning to place concrete during night hours when air temperatures are at a minimum. Since there are certain disadvantages in connection with placing concrete at night, an effort was then made to cool the pipe-line water, thereby making it possible to continue work during daylight hours. For this purpose, a water-cooling tower was constructed, which proved to be very effective in lowering water temperature and maintaining consistently lower concrete temperatures during placing periods.

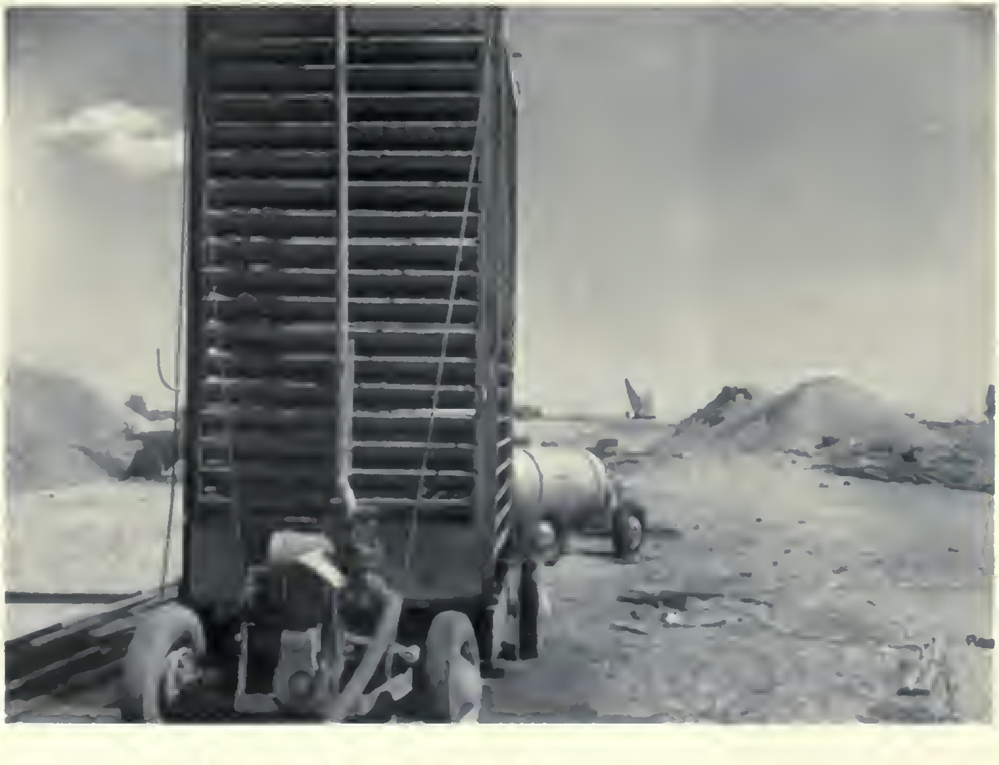
This cooling tower is designed after the usual type of evaporative tower, with sides built of 1- by 6-inch slats sloping toward the center of the tower. That method of construction tends to minimize losses, and provides for diffusion as water falls from the top of the tower to the storage tank. The main supply line is discharged at the top of the tower through perforated pipes, and an even distribution is maintained over the entire cross section of the tower. Further distribution through the 10-foot height of the tower is accomplished by the use of quarter-inch screens, placed in horizontal positions, and at 2-foot centers vertically, within the sides of the tower. The base storage tank has a capacity of 220 gallons. This has been ample to supply the concrete mixer with cooled water even during periods of greatest activity. Inflow to the tower is controlled by a float valve placed in the storage tank.

A 1½-inch centrifugal pump is mounted near the base and outside of the tower, and is used to recirculate water from the storage tank through the tower as many times as possible before it is drawn off. A two-way valve, placed in the discharge line of this pump, makes possible delivery to the mixer, or recirculation over the tower between batches of concrete, in order to produce further cooling. The entire tower, including the storage tank and circulating pumps, is mounted on a chassis having pneumatic-tired wheels.

Over a 22-day period during May 1940, a series of temperature readings was taken in the main supply line. Data were obtained on the temperature of the water after being cooled; the temperature of the concrete being placed; and atmospheric temperatures and relative humidity at various hours during the day and night. These readings are indicated graphically on the appended chart.

From the chart it may be learned that the temperature of the concrete being placed during the daytime was kept below 90° F. until May 11 and May 13, when the temperature of the water in the pipe line reached 133°

Portable cooling tower used for pre-cooling concrete-mixing water on Coachella Branch of All-American Canal



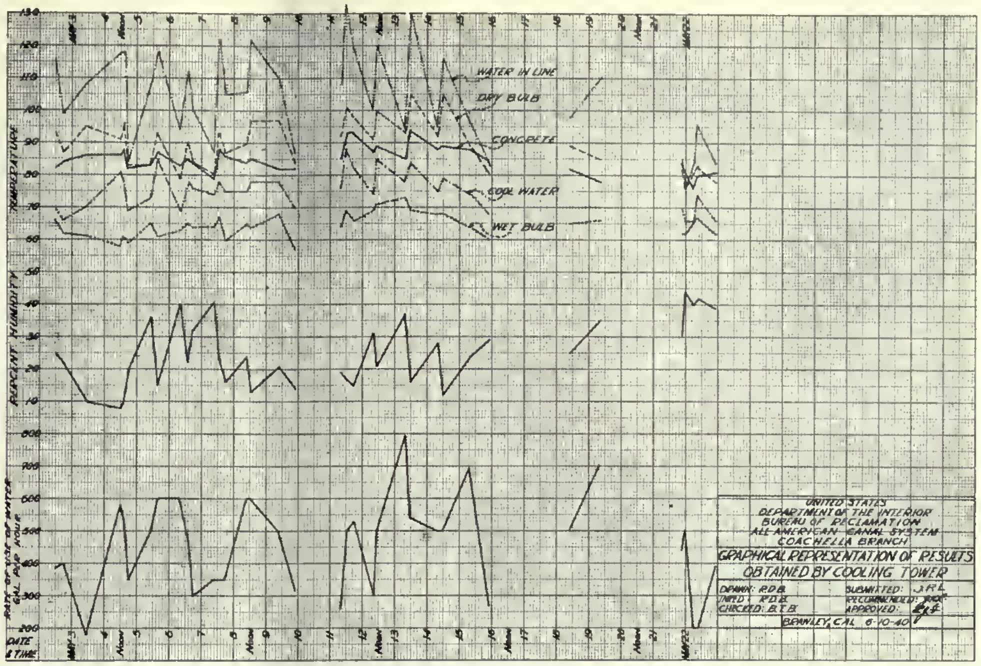
F. and 130° F., respectively. After May 13, it was necessary to place concrete during the night and forenoon, since the effectiveness of the cooling tower was inadequate to offset high temperatures obtaining during the afternoon periods.

A study of the temperature chart will reveal many interesting conditions, and will indicate the effect of the several factors that control concrete temperature. For instance, shortly after noon on May 9 it will be noticed that the curves which represent these factors begin to go downward. It would be expected that this condition would bring about lower concrete temperatures, but instead they remain constant. This is thought to be due to the fact that the temperature of the concrete aggregates, although it is not indicated on the chart, is sufficiently high to offset all the other controlling factors.

Just before noon on May 6, while the "Water in Pipe Line," "Dry Bulb" and "Wet Bulb" temperatures are rising rapidly, the "Percent of Humidity" and "Rate of Use of Water" are falling, and the effect of these two factors seems to be sufficient to allow only a slight increase in concrete temperatures.

The effect of "The Rate of Use of Water" was especially great in controlling concrete temperature. The cooling tower is designed to allow water to pass through it at least twice before entering the mixer. If the mixing operations were retarded, and the water allowed to pass through the tower a greater number of times, the temperature of water from the pipe line was greatly decreased.

It is interesting to note that the efficiency of the tower reached a maximum at 7 a. m. on May 22, when the temperature of cooled water equaled the temperature of the wet-bulb thermometer or 66° F. This condition was reached when all factors were favorable to the high efficiency of the tower; that is, the "Rate of Use of Water" was low, and the temperature of the water in the pipe line was also comparatively low.



It appears that the greatest effectiveness of the tower was reached at noon on May 13. At this time, the controlling factors were less favorable to high efficiency—the temperature of the water in the pipe line was 130° F., and the "Rate of Use of Water" was comparatively high, being approximately 540 gallons per hour. In spite of these conditions, the temperature of the water in the pipe line was lowered from 130° to 84° F. In this case, the high efficiency of the tower is the result of the comparatively low "Percent of Humidity," which was 16 percent.

As the chart indicates, the water-cooling tower proved to be a very effective and economical method of maintaining low concrete temperatures and making possible the placing of concrete throughout the month of May. Without the use of the cooling tower, it would have been difficult, if not impossible, in the face of the high normal air temperatures and the method employed in transporting water by a long pipe line, to have placed concrete throughout the entire period permitted by the specifications.

Earth-fill Construction, Green Mountain Dam, Colorado-Big Thompson Project, Colorado

By R. B. WARD, *Acting Construction Engineer*

STRIPPING of unsuitable materials from the foundation of the lower half of the Green Mountain Dam was carried on by the contractor throughout most of the past winter and spring months. This work exposed suitable foundation over the area to be occupied by the permanent cofferdam section of the dam so that work could have been started on placing earth-fill materials early in April if the contractor's separating machine had been ready for use.

Materials available from abutment stripping and borrow pits are suitable for use in the earth-fill section of the dam, but contain a large percentage of glacial cobbles and boulders. The specifications for construction of Green Mountain Dam permit earth-fill materials to contain rocks that will pass through a grizzly with 3-inch openings, which is the reason for the contractor's separating machine. This machine was especially designed and constructed for use at this dam and is believed to be of a type never before tried for separating earth materials. It is constructed of structural steel and is 32 feet 6 inches long, 30 feet 6 inches wide, and 25 feet 9 inches high, and is mounted on two caterpillar treads, each propelled by a 75-horsepower motor. Total weight of the machine is about 100 tons.

Separation of materials is accomplished by four 5- by 8-foot shake-out screens with 3- by 6-inch openings. The screens are mounted in pairs placed end to end, by which arrangement 16 linear feet of screen is provided. The pitch of the screens may be varied from 3 to 13½ degrees, and each is vibrated by a shaft one-fourth inch eccentrically mounted and driven by a 30-horsepower, 1,670-revolutions-per-minute motor.

Bin space for fine material is provided under the screens for two truckloads, or about 40 cubic yards of material. Horizontal bin gates for loading the screened material are operated by a 40-horsepower motor. At the lower end of the screens there are two rock skips with combined capacity of a little more than a truckload. Each skip is operated independently and is brouht to dumping position by means of a 40-horsepower motor. The material retained by the screens and dumped from

Cofferdam, with diversion dam and tunnel in foreground; main dam foundation in central background

the skips is used in the pervious section of the dam.

All the motors on the processing machine, of which there are 9, operate on 440-volt, 3-phase, 60 cycle current with incoming power at 2,300 volts.

Construction and erection of the processing machine apparently required more time than was anticipated, for it was May 20 when the first material was made available for use in construction of the embankment.

All earth embankment operations have been confined to the permanent cofferdam section of the dam. This cofferdam will form the upstream toe of the main dam and will be about 80 feet high, with a 20-foot crest width and 3:1 and 2:1 slopes respectively on the upstream and downstream faces.

The usual method of earth-fill construction has been followed, namely, placing compacted layers of about 6-inch thickness. The material is transported to the embankment in trucks, dumped in windrows, spread in layers of about 8-inch thickness, and compacted principally by tamping rollers making 12 trips over each layer. Compaction along the cut-off walls, the abutments, and locations inaccessible to the rollers is accomplished by hand-operated air hammers.

The material available for the impervious section of the dam is glacial drift containing about 20 percent cobblestones and boulders more than 3 inches in size. The remaining portion of the material, that which passes through the screens, is excellent for rolled embankment construction, for when compacted at an average moisture content of 9.2 percent, wet-weight densities average 148.4 pounds per cubic foot, with several tests in excess of 150 pounds. About 65 percent of the minus 3-inch material will pass through a one-fourth-inch screen and has average dry weight densities of 130.6 pounds per cubic foot and an average percolation rate of 0.20 foot per year.

Eden Project, Wyoming, Approved for Construction

CONSTRUCTION by the Bureau of Reclamation of the Eden irrigation project, Wyoming, has been approved by the President as announced by Secretary of the Interior Harold L. Ickes on September 23.

The project is located in southwestern Wyoming near the town of Eden in Sweetwater County. It comprises 20,000 acres and will cost $2,445,000, of which at least $1,200,000 will be repaid in not more than 40 annual installments. The balance of the cost is to be divided between the Work Projects Administration and the Civilian Conservation Corps.

The construction of the project will include the rehabilitation of an irrigation system built 30 years ago under the authority of the Carey Act of 1894. The distribution system will be improved and enlarged, new storage works will be built, and a drainage system will be added.

The Carey Act donated public land to the Western States to encourage their settlement and development by means of irrigation construction. Few States took advantage of the grant, many of the irrigation ventures failed for lack of adequate engineering and administration, leading to participation by the Federal Government through the reclamation law of 1902.

The Eden project was one of the irrigation projects which found itself faced with insufficient storage capacity during prolonged drought. Instead of providing water for 30,000 acres, as originally planned, the project was able to take care of only 9,000 acres.

This is the sixth of the "relief" water conservation projects approved by the President for construction in the Plains region of the United States, an area hard hit by drought and depression.

The other five projects approved are: Buffalo Rapids, 25,300 acres, Montana; Buford-Trenton, 13,400 acres, North Dakota; Rapid Valley, 12,000 acres, South Dakota; Mirage Flats, 12,000 acres, Nebraska; and Bismarck, 4,876 acres, North Dakota.

All the projects aim at steadying the shaky agricultural life of the Plains region which has been losing its population because of drought and duststorms. They will offer settlement opportunities to farmless farm families by subdividing present land holdings into small family-size irrigated farms with diversified cropping. All the projects will use relief labor for their construction.

The lands to be irrigated on the Eden project are situated along both sides of Little and Big Sandy Creeks at and above their confluence. The soils of the project are predominantly sandy loams and under irrigation are capable of furnishing good yields of alfalfa, sweet clover, grains, and similar crops. The surrounding country contains some excellent range land. The principal industry of the present project is dairying, a ready market for the products of which is found at Rock Springs, Wyo.

The existing irrigation facilities comprise the Eden Reservoir of 12,300 acre-feet capacity, four small reservoirs at the headwaters of Big Sandy Creek of 2,500 acre-feet aggregate capacity, the Eden Canal, 20 miles long, and a comprehensive system of laterals. The plan of development includes the construction of a new reservoir on Big Sandy Creek, as the investigations indicate that this will be more economical than the rehabilitation of the existing dam. It will be necessary to construct a 4-mile outlet canal, to rehabilitate the present canal and distribution system, and to construct a drainage system for the 20,000 acres to be included in the project. The development program will also include the necessary rough-land leveling.

NOTES FOR CONTRACTORS

Specification No.	Project	Bids opened	Work or material	Low bidder		Bid	Terms	Award of contract approved
				Name	Address			
1387-D	Pine River, Colo	July 29	Relocated road from stations 231 to 320, Vallecito Reservoir.	Wood, Morgan & Burnett Construction Co	Durango, Colo	$14,952.66		Sept. 3
1390-D	Ogden River, Utah	Aug. 5	Construction of pipe lines on laterals 10, 13, 15, 17, and 19, South Ogden distribution system.	Niels Fugal	Pleasant Grove, Utah.	14,756.20		Aug. 22
1391-D	Columbia Basin, Wash.	Aug. 1	10,000 barrels of finely ground standard portland cement in cloth sacks.	Northwestern Portland Cement Co.	Seattle, Wash	[1] 23,346.00	Discount 10 cents per barrel.	Do.
1392-D	Colorado-Big Thompson, Colo.	Aug. 9	Installation of heating system for garage at Estes Park headquarters.	The City Plumbing & Heating Co.	Boulder, Colo	3,112.00		Aug. 19
1393-D	do	Aug. 12	Installation of heating system for garage at Shadow Mountain camp.	Whelan Heating & Engineering Co.	Denver, Colo	3,189.00		Aug. 20
1399-D	Boulder Canyon, Ariz.-Nev.	Aug. 20	Coupling capacitators, distribution transformers with protective devices and accessories and carrier line traps for Boulder power plant.	Westinghouse Electric & Manufacturing Co.	do	[2] 10,776.00	F. o. b. Boulder City	[3] Sept. 6
1404-D	Colorado River, Tex	Aug. 22	228 trashracks for outlet works at Marshall Ford Dam.	Worden-Allen Co	Milwaukee, Wis	36,820.00		[3] Sept. 4
1406-D	Yakima-Roza, Wash	Aug. 26	Construction of 1 4-room residence and 1 double garage at the Roza diversion dam.	A. S. Long	Yakima, Wash	5,326.50		Sept. 3
1411-D	Owyhee, Oreg.-Idaho	do	2 welded plate-steel pipes for Gem pumping plant.	Beall Pipe and Tank Corporation.	Portland, Oreg	3,279.00		Do.
E-23,077-A	Boulder Canyon, Ariz.-Nev.	July 31	Electrical switching, metering and protective equipment for Las Vegas circuit and 40,000-kilovolt-ampere Industrial circuit.	Westinghouse Electric & Manufacturing Co.	Denver, Colo.[4]	11,960.00	F. o. b. Boulder City	Aug. 30
919	Columbia Basin, Wash. Ariz.	Aug. 5	Electric elevators and elevator hoistway doors for Grand Coulee Dam and power plant.	Otis Elevator Co	San Francisco, Calif	187,352.00	F. o. b. various plants	Do.
923	Boulder City, Ariz.-Nev.	Aug. 6	Generator (82,500 kilovolt-ampere) for unit A-5 Boulder power plant.	General Electric Co	Schenectady, N. Y	700,000.00		Aug. 31
1395-D	Sun River, Mont	Aug. 19	Construction of concrete lining for tunnel No. 1, Pishkun Canal.	Williams Construction Co	Helena, Mont	18,610.00		Sept. 6
1396-D	Tucumcari, N. Mex	Aug. 22	Construction of irrigation outlet at Conchas Reservoir and rating section at station 0+60, Conchas Canal.	Henry Shore	Grand Junction, Colo.	23,600.40		Do.
1397-D	Yakima-Roza, Wash	Aug. 19	Furnishing and delivering in stock piles 7,600 tons of sand and 12,000 tons of gravel.	L. C. Curtis & Sons	Kettle Falls, Wash	[5] 10,780.00 [6] 12,740.00		Do. Do.
1401-D	Parker Dam Power, Ariz.	Aug. 22	1 oil purifier and 1 filter paper drying oven for Parker power plant.	The DeLaval Separator Co	Chicago, Ill	[2] 4,720.00	F. o. b. Poughkeepsie, N. Y.	Sept. 4
926	Provo River, Utah	Aug. 21	Construction of Duchesne Tunnel, stations 163+35 to 321+75.	Utah Construction Co	Ogden, Utah	727,575.00		Sept. 6
1394-D	Yakima-Roza, Wash	Aug. 16	Earthwork, pipe line and structures, laterals G-15.0 to G-28.7 and sublaterals, Yakima Ridge Canal; earthwork and structures, drain "D."	Valley Construction Co	Seattle, Wash	[5] 30,997.54		Sept. 7
1398-D	Colorado-Big Thompson, Colo.	Aug. 19	Absorptive form lining (83,000 square feet).	Dant & Russell, Inc	Portland, Oreg	2,905.00	F. o. b. Kremmling, Colo.	Sept. 5
1405-D	Kendrick, Wyo	Aug. 23	Precast reinforced concrete pipe	Elk River Concrete Products Co.	Helena, Mont	4,892.40		Sept. 4
1410-D	Gila, Ariz	Aug. 27	6 pump-discharge pipes for pumping plant No. 1.	California Steel Products Co.	San Francisco, Calif	3,998.00	Discount 1 percent	Sept. 6
1414-D	Columbia Basin, Wash	Aug. 29	6 welded plate-steel tanks	Berkeley Steel Construction Co., Inc.	Berkeley, Calif	1,665.00	Discount ½ percent	Do.
020	do	Aug. 12	150-ton gantry crane, with auxiliary trolley of 27-ton capacity for Grand Coulee Dam.	Star Iron & Steel Co	Tacoma, Wash	105,380.00		Sept. 9
924	do	Aug. 19	Superstructures for 1 highway and 2 railroad bridges over Kettle River.	Norris Bros	Burlington, Wash	[4] 139,736.00	Shipping point, Des Moines, Iowa.	Do.
B-38,450-A	do	Aug. 27	Railroad ties	National Pole & Treating Co Forest Products Treating Co	Minneapolis, Minn Portland, Oreg	[4] 137,983.70 [7] 1,360.00	F. o. b. Hillyard, Wash F. o. b. Eugene, Oreg	Do. Sept. 3
925	do	Aug. 12	Residences at Leavenworth, Entiat, and Winthrop stations for migratory fish control.	W. J. Park & Son West Coast Construction Co	Yakima, Wash Seattle, Wash	[4] 55,858.00 [7] 29,381.00		Sept. 10 Do.
1409-D	Ogden River, Utah	Aug. 27	Fabricated steel pipe, 4-inch to 20-inch o.d.	Southern Pipe & Casing Co	Azusa, Calif	35,889.21	F. o. b. Ogden, Utah	Sept. 12
1415-D	Boulder Canyon, Ariz.-Nev.	Aug. 30	2 plate-steel turbine inlet pipes for units A-1 and A-2, Boulder power plant.	Consolidated Steel Corporation Ltd.	Los Angeles, Calif	13,900.00		Do.
1416-D	Columbia Basin, Wash.	do	10 gate-slot closures for trashrack structures for outlet works at Grand Coulee Dam.	St. Paul Foundry Co	St. Paul, Minn	6,836.00		Sept. 9
34,018-C	Mirage Flats, Nebr	Sept. 3	3 95-horsepower Diesel-engine-powered, crawler tractors.	Caterpillar Tractor Co	Peoria, Ill	[8] 25,013.22	Discount $50, each unit	Sept. 14
1400-D	Columbia Basin, Wash.	Aug. 21	Carrier-current telephone apparatus for Grand Coulee power plant.	Westinghouse Electric & Manufacturing Co. General Electric Co	Denver, Colo Schenectady, N. Y	[5] 8,000.00 [6] 5,775.00	F. o. b. Almira, Wash do	Sept. 12 Do.
1413-D	Gila, Ariz	Aug. 28	32-ton, motor-operated, overhead traveling crane for pumping plant No. 1.	Shaw-Box Crane & Hoist Division (Manning, Maxwell & Moore, Inc.).	Muskegon, Mich	8,949.00		Sept. 13
1412-D	Parker Dam Power, Calif.-Ariz.	do	2 carbon-dioxide fire-extinguishing systems; 15 spare cylinders of carbon-dioxide.	C-O-Two Fire Equipment Co.	Newark, N. J	[8] 3,799.50 [9] 1,102.50	F. o. b. Earp, Calif do	Sept 11 Do.
1418-D	Columbia Basin, Wash.	Sept. 4	2 carbon-dioxide fire-extinguishing systems, 26 spare cylinders of carbon-dioxide.	do	do	[8] 7,385.00 [6] 1,911.00	F. o. b. Odair, Wash	Do. Do.
1403-D	do	Aug. 22	Spiral stairways for installation in Grand Coulee Dam.	St. Paul Foundry Co	St. Paul, Minn	20,211.00		Sept. 13
1420-D	do	Sept. 11	Construction of pipe lines on laterals on South Ogden distribution system.	Enoch Smith	Salt Lake City, Utah.	8,234.50		Sept. 18
1419-D	Boulder Canyon, Ariz.-Nev.	Sept. 9	Anchor jacks for headers of outlet pipes at Boulder Dam.	Schmitt Steel Co	Portland, Oreg	31,450.00		Sept. 24
21,186-A	Boise-Payette, Idaho, and Owyhee, Oreg.-Idaho.	Sept.	5,000 barrels of standard portland cement in cloth sacks.	Oregon Portland Cement Co.	do	13,000.00	F. o. b. Lime, Oreg.; discount and sack allowance $0.50 per barrel.	Do.

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[1] Items 1, 2, and 3. [2] Items 1 and 2. [3] All bids rejected. [4] Schedules 1 and 2. [5] Schedule 1. [6] Schedule 2. [7] Schedule 3. [8] Item 1. [9] Item 2.

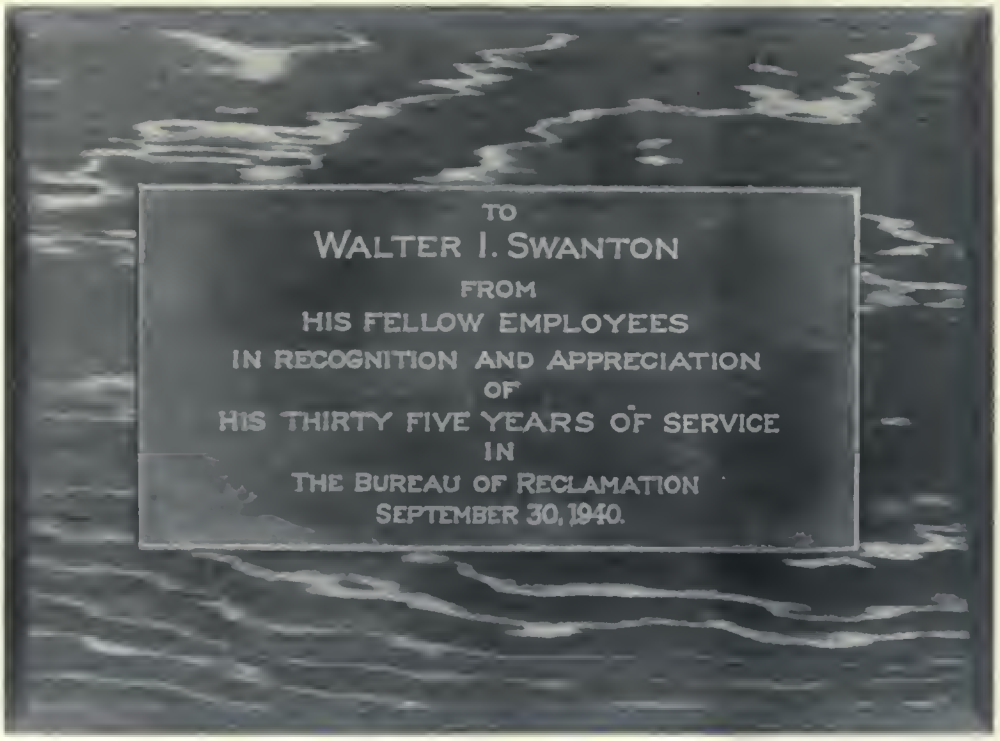
Walter I. Swanton Retires

AFTER 35 years of service with the Supervising Architect's Office and the Bureau of Reclamation, W. I. Swanton, an associate (civil) engineer in the Engineering Division of the Washington office, was retired on September 30 with the best of wishes from the entire personnel of the Bureau, to whom he had endeared himself by service and good fellowship. He was presented with an engraved plaque which carries this sentiment, a reproduction of which appears on this page.

Mr. Swanton was born September 6, 1869, at St. Joseph, Mo. He graduated from the Gardiner, Maine, high school in 1889, from the Massachusetts Institute of Technology in 1893, and later from the National Law School. He possesses degrees of B. S., B. A., and M. A.

Before his entrance in the service of the Bureau, he was employed in the engineering department of the Boston & Albany Railroad in 1899; then with the Union Bridge Works, Athens, Pa.; Edgemore Bridge Works; and Bureau of Yards and Docks, Navy Department, at the Norfolk, League Island, Boston, and Brooklyn Navy Yards.

W. I. Swanton



TO
WALTER I. SWANTON
FROM
HIS FELLOW EMPLOYEES
IN RECOGNITION AND APPRECIATION
OF
HIS THIRTY FIVE YEARS OF SERVICE
IN
THE BUREAU OF RECLAMATION
SEPTEMBER 30, 1940.

Plaque presented to Mr. Swanton

In 1916, while in the service of the Bureau, Mr. Swanton had charge of the exhibit of the Bureau on the Government Safety-First train which toured the West as far as Salt Lake City. He established the engineering reference library in the Washington office, consisting of about 7,000 books, including nearly 1,500 volumes of histories of the various irrigation projects. He is the author of Guide to United States Government Publications: List of Libraries in the District of Columbia, printed by the National Research Council of Washington; List of Map Collections of Washington, issued by the Board of Surveys and Maps, and a number of articles appearing in the Bureau's monthly magazine, THE RECLAMATION ERA. A popular feature from Mr. Swanton's pen carried over a period of years in the magazine is the compilation entitled "Articles on Irrigation and Related Subjects." His last contribution on this subject appears at page 286 of this issue.

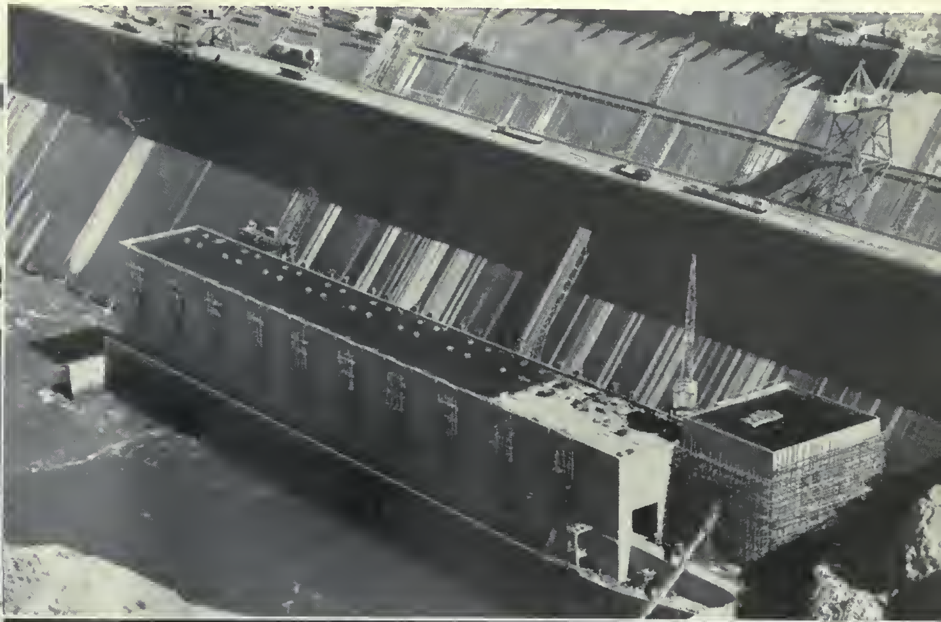
Mr. Swanton is a member of the American Society of Engineers, National Society of Professional Engineers, Washington Society of Engineers, and Federal Employees Union (Local No. 2).

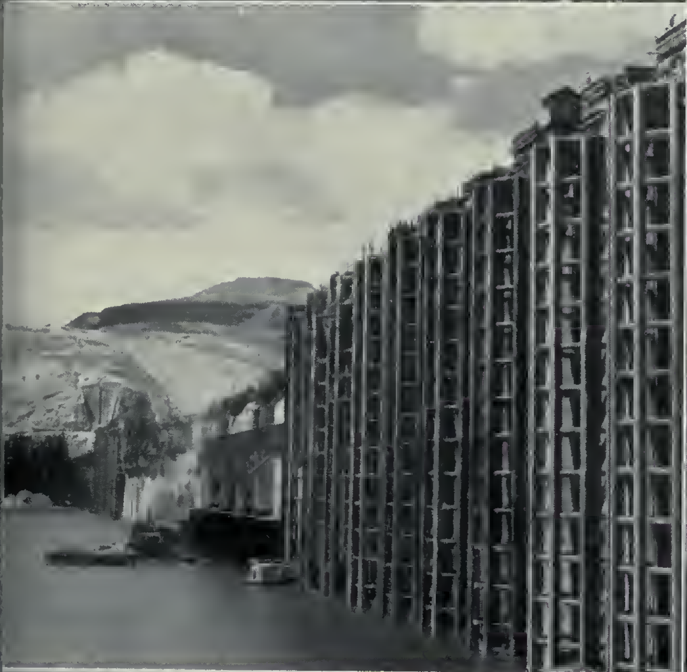
Mr. Swanton has an active and alert mind and retirement for him means more time to give to his personal interests, prominent among which is his activity in civic affairs. He is a member of the District of Columbia Library Association, Columbia Heights Citizens Association, and Executive Committee of the Federation of Citizens Associations.

With Mr. Swanton goes the best wishes of the office staff—those who have worked with him during his entire tenure in office and those who came to work for the Bureau in later years. All have an affectionate regard for this co-worker who "lays down his pencil" in his office in the new Interior Building to enjoy a well-merited retirement from the Bureau of Reclamation.—M.A.S.

John F. Sikes, Chief Photographer of the Bureau of Reclamation, reported for active duty in the United States Navy on August 15, his station Norfolk, Va. He is the first of the Bureau's Washington Office staff to leave for defense service

GRAND COULEE DAM NEARS COMPLETION





Origin of Names of Projects and Project Features in Reclamation Territory[1]

Shoshone Project, Wyoming

Shoshone.—Named after range of mountains and river bearing same name. The river is the source of water supply for the project. It was originally called the Stinking Water by the Indians on account of the sulphur springs near the mouth of Shoshone Canyon. It is understood that the name Stinking Water was later changed to Shoshone River by the Board of Geographic Names in the Department of the Interior in honor of the Shoshoni tribe of Indians. No reason has been found for changing the last letter of the tribal Indian name from i to e.

Heart Mountain.—There is considerable local dispute over the spelling and origin of the name "Heart Mountain." The word "Heart" is spelled "Hart" by residents of Cody and vicinity, and "Heart" by other people on the project. The name apparently was applied to the mountain because it stuck up sharply like a human or animal heart and means nothing more than that the mountain is heart-shaped.

Corbett.—The railroad station of Corbett was established by the C., B. & Q. Railroad Co. on October 2, 1901. Chief Engineer F. T. Darrow of the Burlington Railroad states that "during construction of the Cody division of the railroad there was a bridge over the Shoshone River 6 or 7 miles below Cody and the place was called Corbett. Right near the bridge was an old abandoned building which had been a saloon. The old weather-beaten sign was still on it above the door. Possibly the saloonkeeper's name, Corbett, was given to the town, or possibly it was named for James J. Corbett, world's heavyweight champion for some years prior to 1901."

Ralston.—Val Kuska, colonization agent of the C. B. & Q. Railroad Co., informs us that the town of Ralston was named by T. E. Calvert, general superintendent of Lines West and later chief engineer for the Burlington, and so far as he can discover, the name has no local significance. The reservoir is near the town and was named Ralston by the Bureau of Reclamation.

Powell.—The town was originally started as a Reclamation Service camp. The town was named "Powell" on October 30, 1907, in honor of Maj. John W. Powell, famous American geologist and explorer, known especially for his valuable surveys of the Colorado River regions. One result of his work was the organization of the United States Geological Survey, of which he was director from 1881 to 1894.

Garland.—This is the oldest town on the project and a railroad station was established there on September 10, 1901. Mr. Kuska advises that the town was named by T. E. Calvert and has no local significance.

Willwood.—One interpretation of the origin of this name is that it is a combination of part of some person's first name and surname, and that it was given by the Bureau of Reclamation. Mr. Kuska is of the opinion that the name was given in honor of Will Wood, Member of Congress, who was at one time the chairman of the subcommittee on appropriations for reclamation. Local people understand that the name was given in honor of Wilford Woodruff, an official in the Mormon Church, who had much to do with the reclamation of the Big Horn Basin.

Frannie.—Mr. Kuska informs us that Frannie was named for Frannie Morris, daughter of a ranchman residing near the present town of Frannie, who entertained pathfinders coming out in advance of engineers and graders and tracklayers to pick out a mail route. She was a cowgirl, familiar with the best and the worst of frontier life, who afterwards carried the mail from the train to the ranch post office where her father was postmaster, and performed the stunt picturesquely enough to amaze and amuse easterners who made early trips over the road. The Frannie station was opened on September 2, 1901.

Shoshone Dam and Powerhouse, Shoshone Project, Wyo.

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[1] A compilation of data furnished by field offices of the Bureau of Reclamation.

Deaver.—To Mr. Kuska we are also indebted for the information that Deaver was named for D. Clem Deaver, who was immigration agent for the Burlington Railroad from 1905 to 1914.

Rio Grande Project, New Mexico-Texas

Rio Grande.—This name, as applied to the river, valley, and project, is of Spanish derivation meaning "large river." The river traverses the length of the project and is the source of the project's irrigation water supply. The project is located in the central portion of the Rio Grande Valley in south central New Mexico and extreme west Texas.

To the old Spanish settlers or colonists the Rio Grande was sometimes referred to as Rio Bravo del Norte (the fierce, wild river of the north), and this is still the official Mexican name for the river along that section which forms the international boundary line between the United States and Mexico from El Paso to the Gulf of Mexico. However, there seems to be a tendency to drop "Del Norte" from the name and refer to it in the official Mexican records as "Rio Bravo."

Elephant Butte dam and reservoir.—When first proposed the dam and reservoir were variously referred to as Elephant Butte dam and reservoir; Engle dam and reservoir, after the nearest railroad station on the Albuquerque-El Paso branch of the Santa Fe Railroad about 12 miles east of the dam site; Rio Grande Dam, because it was the first large storage dam approved for construction on the Rio Grande. Ultimately taking the name from a huge eruptive mass of volcanic origin rising abruptly to a height of 500 feet, at the base of which the Rio Grande flowed about one-half mile above the dam site and which bears a striking resemblance to a gigantic elephant's head, the dam and reservoir have come to bear the recognized designation. This butte or semicrater, being located in the reservoir area, becomes surrounded by water and forms an island when the water surface of the lake reaches elevation 4,320, about one-half the height of the dam above the old river bed.

The reservoir stores the entire flood discharge of the Rio Grande,, reaching it from south central Colorado and north and south central New Mexico, 26,000 square miles, and releases from the reservoir under control have furnished the well regulated irrigation water supply for the Rio Grande project since storage in the reservoir began in 1915.

Caballo dam and reservoir.—The Spanish name "Caballo," meaning "horse," was taken from a range of mountains bordering the east side of the Rio Grande Valley along that section which forms the Caballo Reservoir.

Rincon division.—The Rincon Valley portion of the Rio Grande Valley constitutes the Rincon division of the Rio Grande project. This name is applied to the local portion of the Rio Grande Valley because of a curve in the river and the valley to the east for a few miles and then again to the south, "Rincon" being Spanish for "corner" or "turn." The name was probably first applied, however, to the station or town of Rincon on the Santa Fe Railroad.

Percha diversion dam.—The name "Percha" originally was "Esa Percha," which in English would be translated "that roost" or "that perch," and was, according to early settlers, named by the natives for a large grove of cottonwood trees at the mouth of the creek in which crows roosted or perched during the night.

El Paso.—"El Paso" is Spanish for "the pass," hence the city takes its name from the fact that at this point the Rio Grande passes between two small ranges of mountains. In the days of the Spanish colonization of New Mexico, this point on the trail from Mexico City to the Spanish colonies in the vicinity of Santa Fe, New Mexico, was known as El Paso del Norte, "the pass of the north," the original name for the old Mexican town of Juarez, located on the south side of the Rio Grande opposite El Paso. As the name El Paso has been applied to the city it has also been extended to that portion of the Rio Grande Valley at the extreme upper end of which El Paso is located. This valley constitutes the El Paso division of the project.

Juarez.—The old Mexican settlement of El Paso del Norte, which was founded more than 200 years earlier than El Paso, was renamed Ciudad Juarez in honor of Benito Juarez, who is celebrated as the liberator (or George Washington) of Mexico.

Sierra County.—Sierra County is the county in which are located Elephant Butte, Caballo, and Percha diversion dams, as well as a small section of the irrigated lands of the project. The Spanish name "Sierra" means mountains, and doubtless was given

Buck Springs Creek Siphon (Shoshone project) viewed from Heart Mountain Canal Backfill operations on monolithic concrete barrel section in background.

Upper: Elephant Butte Dam and Powerhouse; *lower:* Caballo Dam. Rio Grande Project, N. Mex.-Tex.

because of the many mountain ranges in the county.

Hatch.—The town of Hatch, N. Mex., which is the chief agricultural center for the Rincon Valley, was named after a railroad location and construction engineer when the Santa Fe Railroad was built through the Rincon Valley.

Dona Ana County.—This county joins Sierra County on its southern boundary and El Paso County on its northern boundary. It includes the Leasburg division and the Mesilla Valley, N. Mex., and has as its county seat the town of Las Cruces. The name "Dona Ana" was probably derived from the Dona Ana Bend Colony Grant, which was issued in 1839 or 1840. The tradition connected with the name, which cannot be verified, is that at the time the Dona Grant was applied for or issued, Indians in the vicinity of the present settlement kidnaped the daughter of one of the Spanish or Mexican settlers whose name was Anita. Anita is the diminutive for Ana; the "Dona," of course, being the designation for a lady of some prestige, although not actually of the nobility.

Leasburg diversion dam.—The name "Leasburg" is derived from a Federal soldier named Adolph Lee or Lea, who came to the vicinity during the Civil War period or shortly thereafter. This soldier established a canteen and general merchandise store, and eventually settled in the vicinity after his discharge from the Army. He also established in the vicinity of the present Leasburg diversion dam a river ferry which was of considerable importance during the period prior to the construction of the Santa Fe Railroad in 1881. Incidentally, Fort Selden was established in the immediate vicinity in 1865, and it is possible that the soldier Lee arrived at the time of the establishment of the fort. This post was abandoned in 1879, and reoccupied in 1881 during an Apache uprising, and also to protect railroad construction crews in the vicinity. The fort was abandoned finally in 1892. The fort was named after Col. Henry R. Selden. In the location on which it was finally constructed, it is probable that the dam could more appropriately have been named Selden diversion dam.

Mesilla Valley.—The Mesilla Valley is the largest division of the project and takes its name from Spanish which means "little mesa" or "little table." This designation was probably applied to this area because the land in the valley presented a comparatively flat surface.

Las Cruces.—Las Cruces, the largest town outside of El Paso and the principal town in the New Mexico section of the project, takes its name from the fact that at the site of the town there was originally a number of crosses which had been placed on graves of three priests or missionaries who had been massacred by Indians near this spot. The settlers of Dona Ana buried the priests at the site of the massacre and erected crosses over the graves. Later on, according to tradition, other people were massacred by the Indians and their bodies buried near the graves of the 3 priests. It is said at one time the burial ground contained about 40 crosses. Las Cruces was originally surveyed by an Army officer named Chapman in 1848, although the actual settlement o the town did not begin for a year or two after the initial survey.

Anthony.—Anthony is an agricultural center between El Paso and Las Cruces, its distinction being that the State line Texas-New Mexico passes through the center of the town. The town actually has two names, that on the New Mexico side being named Anthony, while the Santa Fe Railroad Station of the town is on the Texas side, and is named La Tuna. The name "Anthony" according to several of the old settlers still living in the vicinity of the town originated with an early settler who moved in from Anthony, Kans. It is said that as a result of two towns both being Anthony on the Santa Fe Railroad that some confusion became evident in 1908. In order to avoid this confusion the railroad station name was changed to La Tuna. Local tradition gives the derivation of the name "La Tuna" to the fact that in the year the change of names was made a species of cacti was heavily fruited, the fruit being called "tuna" or "la tuna," and evidently the natives or the local station agent prevailed upon the railroad to designate the railroad station as "La Tuna." At the present time the two names are still used. The railroad station is located on the south edge of town and is designated as La Tuna being in Texas, while the post office within several city blocks is located across the New Mexico State line and is designated as Anthony.

Ysleta.—Ysleta was established by the Spaniards who were driven out of New Mexico as the result of the Pueblo Indian uprising in 1680. The Spaniards retreated to Paso del Norte and brought with them several hundred Indian converts from the various New Mexico pueblos of La Isleta, Socorro, Senecu, and others. The new settlements which they established in a line along the valley below Paso del Norte, and at that time all on the south side of the Rio Grande, they named after the New Mexico pueblos from which they had retreated. The Indians from La Isleta were settled in the new pueblo about 11 miles below Paso del Norte, and the governor designated this new pueblo Corpus Christi de La Isleta. It seems that the name "La Isleta" was given to the original pueblo in New Mexico because the Rio Grande gradually eroded the banks of the pueblo and eventually formed a small island, the word "Isleta" meaning "small island." The Spanish governor in order to distinguish the new pueblo from the old in all probability added the "Corpus Christi" to the name. Probably due to Anglo influence, the "I" in Isleta was later dropped and "Y" substituted. It is said without verification that this change probably resulted from the fact that in old Spanish writing the capital "I" resembled an English "Y."

Socorro.—Socorro is also located in the El Paso Valley and was founded by Indian refugees driven out of their pueblo called Nuestra Senora del Socorro, which had been founded in 1626 in New Mexico, some miles south of the Isleta pueblo, by Spanish missionaries. However, the original location of the new Socorro was not at the present location of the little settlement, but according to evidence available, it originally was located about 22 miles from the newly established Corpus Christi de La Isleta, which would place the location somewhere in the vicinity of the present town of Fabens, approximately 20 miles east of Ysleta. This pueblo, Nuestra Senora del Socorro, was established in 1682, but the location was moved nearer to Isleta in 1683 because of the discontent of the Indians during which an attempt was made to murder the missionary priest. As a result the Spanish governor at Paso del Norte (Juarez) moved the remaining Indians much closer to La Isleta, which is the present location of Socorro. The name "Nuestra Senora del Socorro" may be translated as "our lady of help."

Boat race on Elephant Butte Lake

San Elizario.—As a result of the establishment of the pueblos of Socorro, Isleta, and others, on the Mexican side of the river, the Spanish Governor Otermin in counsel with his advisors and the missionaries decided that a presidio or fort should be established in the vicinity of the pueblos for protection. However, a change in governors took place in 1682, but the new governor did not reach Paso del Norte (Juarez) until 1683, and after acquainting himself with conditions, he established the presidio at the present site of San Elizario. It was abandoned in 1684, and the inhabitants moved to Paso del Norte where it remained probably until 1766, at which time it may have been reestablished at or near the original location. This, however, is not definite. It may be of interest here to say that near San Elizario or between San Elizario and Socorro, Onate first reached the Rio Grande in 1598. The name "San Elizario" is a corruption of the name San Elzearo. In English the name is translated "Saint Elzear," from a French count and a saint of the Catholic Church.

Fabens.—Fabens is the agricultural center of the central and eastern end of the Rio Grande project, and is located in the El Paso Valley in El Paso County. As previously referred to, the original Socorro was established somewhere in the present vicinity of Fabens. The name "Fabens" commemorates a Southern Pacific Railroad official by the name of George Fabens, who was assistant land commissioner for the railroad at the time it was built through the Valley.

Mexican diversion dam.—So called because it was originally constructed to divert water from the Rio Grande into the Acquia Madre, the main irrigation diversion canal for the Juarez Valley, Mexico, but later, however, a canal heading was also constructed on the American side of the Rio Grande just immediately above the dam, which then became a diversion dam for land in both the United States and Mexico, and subsequently was sometimes referred to as the international diversion dam.

American diversion dam.—So called because it has been constructed across the Rio Grande just above the point where the river ceases to be the international boundary line between the United States and Mexico, which is about 2 miles above the Mexican diversion dam. This dam was recently built by the International Boundary Commission to divert from the Rio Grande all of the water for the irrigation requirements of land on the American side below El Paso and to fulfill international treaty requirements by allowing to flow down the Rio Grande to the Mexican diversion dam the quantity of water which has been allocated to Mexico by treaty schedule.

Klamath Project, Oregon-California

Klamath Falls.—This town is located at the falls of Link River, where that stream flows into Lake Ewauna. The place was originally known as Linkville and was named for Link River. The Klamath Indian name for the place was "Yulalona," or "Iuauna," which referred to the peculiar blowing backward of the waters of Link River during strong south winds. The Klamath name for the falls in Link River was "Tiwishkeni," or "rush of falling waters place."

Merrill.—So named for Nathan S. Merrill, who was born in New Hampshire in 1836, and moved to California in 1869. He moved to Chehalis County, Wash., in 1881, and in 1890 settled at the present site of Merrill. He purchased a ranch in the spring of 1894 and laid out a portion of the town of Merrill, which was named for him.

Malin.—This is a rapidly growing community on land that was formerly at the bottom of Tule or Rhett Lake. Tule Lake has been dried up by the Bureau of Reclamation. On September 30, 1909, 65 Bohemian families settled at the present site of Malin and named the place for a town in Bohemia, Czechoslovakia, their former home.

Bonanza.—This is a Spanish word meaning prosperity. The place is said to have been so named because of the presence of a large number of fine springs in the vicinity. Good water is always a source of prosperity in a country that requires irrigation.

Siskiyou Mountains.—George Gibbs, in his "Dictionary of the Chinook Jargon," gives the following version of the origin of this name: "Siskiyou. Cree. A bob-tailed horse." This name, ludicrously enough, has been bestowed on the range of mountains separating Oregon from California, and also on a county in the latter State. The origin of this designation as related by Mr. Anderson was as follows: "Archibald R. McLeod, a chief factor of the Hudson's Bay Co., in the year 1828, while crossing the mountains with a pack train, was overtaken by a snowstorm, in which he lost most of his animals, including a noted bob-tailed race horse. His Canadian followers, in compliment to their chief or 'bourgeois,' named the place the Pass of the Siskiyou—an appellation subsequently adopted as the veritable Indian name of the locality, and which thence extended to the whole range, and the adjoining district." Gibbs' statement that the word came from the Cree language should bear great weight, yet it must be said that there is another origin of the name suggested, the French words "six cailloux," or "six stones." It is supposed that there were six important rock landmarks along the trail that led to this designation. The Siskiyou Mountains are part of what geologists call the Klamath Mountains, which lie as a connecting uplift between the Coast Range and the Cascade Range.

Clear Lake Reservoir.—Named after the fresh-water lake that originally covered about 10,000 acres of the lower portion of the reservoir, which was known as Clear or Wright Lake.

Gerber Reservoir.—Named after Louis Gerber, the former owner of most of the private lands within the reservoir.

Malone Dam.—Named after James Malone, a pioneer of Langell Valley who formerly owned the property on which the dam is located.

Tule Lake.—This lake was discovered May 1, 1846, by John C. Fremont, and later named "Rhett" after his friend, Barnwell Rhett. The name "Tule Lake" was no doubt given by an exploring party in 1846 because of its surroundings. Tule means a certain kind of rush.

Langell Valley.—Named for Arthur Langell, an early settler, who took part in the Modoc War and was afterward killed in an altercation with a neighbor. Langell Valley is a natural geographic feature, and a post office bears the same name.

Modoc Point.—The Indian name "Modoc" is derived from the Klamath words "moa," meaning "south," and "takni," meaning "a native of that place or country," hence from the point of view of the Klamath Indians, natives of the country just to the south. The term "Modoc Lakes" was formerly used in the Klamath country to refer to Tule and Clear Lakes, because Modoc Indians lived nearby.

Lost River.—This stream rises in California and flows into Oregon. It formerly debouched into Tule Lake, but is now controlled for irrigation, and as a result Tule Lake is being dried up and reclaimed for farm land. During its course through Langell Valley Lost River disappears for several miles, hence its name. The famous natural stone bridge, by which the Applegate party crossed Lost River on July 6, 1846, may be seen near Merrill. Lost River was discovered by Fremont early in May 1846, and named McCrady River for a boyhood friend, but that name did not prevail.

Keno.—There are several stories about the name of this place. Capt. O. C. Applegate says that the name first suggested was "Klamath River," but postal authorities objected because of similarity to Klamath Falls. Captain Applegate then suggested "Plevna," and this name for the office was adopted, but later the office was moved away to Juniper Ridge, along with the name. This incensed local patrons and they secured a new office and named it "Keno" for Capt. D. J. Ferree's dog. Nellie Doten, postmistress at Keno in January 1926 informed the writer that her father surveyed and platted the town site and called it "Doten." This name was objected to for a post office because of the similarity to "Dayton." According to her version, the name Keno was then adopted for the office on account of Captain Ferree's birddog. The platted name of the place is still said to be Doten. Keno, the dog, was named after the popular card game of earlier days.

Riverton Project, Wyoming

Riverton project.—The project received its name from the town of Riverton, the project headquarters, though not actually on the project itself. Riverton was founded in 1906 and the name was given it by the early settlers on account of its location near the confluence of the Wind and Little Wind rivers.

Wyoming Canal.—This canal received its name in 1906 when a preliminary survey was made under the direction of the then State engineer, Clarence T. Johnston.

Morton.—Named for Joy Morton, president of the Wyoming Central Irrigation Co. which proposed to build the project in 1906. Mr. Morton was a son of J. Sterling Morton, the first Secretary of Agriculture. He was president of the Morton Salt Co.

Pilot Butte Reservoir.—The origin of this name is evident. The butte is a relatively low, rocky point, rising about 300 feet above the prairie to the south, and about 100 feet above the ridges to the north. It is so located geographically that it is a prominent landmark, being visible for many miles in all directions except south. It is about one mile north of what has always been the main route of travel along Wind River.

Pavillion Butte.—Said to have been so named when the township in which it is located was subdivided by the General Land Office in 1890. The name, a misspelling for "pavilion," probably has reference to its general appearance. The central and highest portion has the appearance of a low cone surmounting vertical cliffs, with two outlying, rocky pinnacles. This butte is also a prominent landmark, visible from all directions except west.

Bull Lake Dam.—There are several versions of the story of the origin of the name "Bull Lake," perhaps the most common being that the Indians once chased a white (albino) buffalo bull in the vicinity of the lake. The bull, being unable to escape his pursuers, jumped into the lake. It is said that he occasionally comes to the lake surface and bellows. The bellowing has some basis in fact. When the lake is frozen over in winter, wind sometimes sweeps down the canyon above the lake, probably raising the ice slightly. When the ice drops back a sound ensues which may resemble somewhat the bellowing of a buffalo.

Lost Wells Butte.—This butte is a prominent feature of the south central part of the project. A deep, narrow canyon, the existence of which is not readily noticed, issues from the northwest corner of the butte. Prior to the present dry cycle, this canyon contained live springs. Now they are hardly more than damp spots. These former springs gave rise to the name "Lost Wells."

The lake resulting from the inflow of storm and irrigation waste water into a large natural depression in the central portion of the project is the largest body of water in Fremont County. For this reason it was named the "Ocean" by local duck hunters.

Wind River.—This designation no doubt was given by early explorers on account of the high winds prevailing through Wind River Canyon, which is located northeast of the project and immediately south of the town of Thermopolis.

Orland Project, California

Orland.—One of the original project settlers came from the town of Orland in England and selected that name for the new town in California, which was laid out about 1875. The project was, of course, named for the principal project town.

Stony Creek.—The source of the project's water supply was named by Gen. John Bidwell, an early California pioneer and a contemporary and one-time employee of General Sutter. History records the creek was so named because of the fact that three men, made grindstones from stone deposits on the upper reaches of the creek, loaded them in canoes, and transported them to points on the Sacramento River where they were sold to ranchers.

Stony Gorge.—The name as applied to the dam and reservoir is of comparatively recent origin. A narrow place in Stony Creek valley just above the town of Elk Creek was investigated as a dam site by Bureau engineers and designated as "Stony Gorge" on their maps, although the name had never been applied to the site by nearby residents.

East Park Reservoir.—This reservoir occupies a site in the foothills of the Coast Range of mountains and, prior to the construction of the dam, the terrane now under water resembled a huge park. It is said that an early resident of the area was named "East" or "Eastern" and the park received its designation from that source.

Two Large Projects to Provide Many Homes

OFFICIALS of the Bureau of Reclamation on September 23 presented statements to a special congressional committee in San Francisco, Calif., to the effect that about 360,000 persons will be able to find new homes and more than 1,000,000 will be able to save or reestablish their old homes as a result of two major Federal Reclamation projects under construction on the Pacific coast.

Grand Coulee Dam on the Columbia River in Washington will make possible the irrigation of 1,200,000 acres of land, and thus provide opportunities for new homes and new communities in the Columbia Basin area, and the Central Valley project in California, with its two mighty dams, Shasta and Friant, will revive approximately 2,000,000 acres of cultivated land by providing a supplemental supply of water.

With Congressman John H. Tolan of California as chairman, this committee was appointed to investigate the causes for the migration of destitute citizens from the Great Plains and other sections. With meetings in San Francisco and Los Angeles the committee concluded a series of hearings in the West. The pressure on the populations of the far Western States, particularly California, by the influx of migrants is of serious concern to those States and to the Nation as a whole.

Columbia Basin Project

Dr. E. N. Torbert, field coordinator of settlement investigations on the Columbia Basin project, outlined the opportunities in that area for settlement of migrants, and stated that under present plans the first land in this project will be available for settlement in 1944.

Discussing the comprehensive studies in progress, Dr. Torbert said that the Bureau of Reclamation has the cooperation of the Department of Agriculture and other Federal and State agencies. Particular attention has been given to the best method of establishing control over privately owned land in order to aid in the settlement of worthy farmers who have been forced off their land by drought. Protection for prospective settlers is afforded through the antispeculation act of 1937, which limits to 40 acres, tracts in individual ownership that may receive water, and assures settlers of opportunities to secure land at nonspeculative prices.

Dr. Torbert further said that the primary objective of the studies is to establish conditions that will enable a settler, by his own efforts, to succeed. Where needy migrants are involved, consideration has been given to ways and means of providing financial and other assistance.

The construction program of the irrigation features of the Columbia Basin project is scheduled to absorb skilled labor now employed on Grand Coulee Dam, nearing completion. The schedule provides for making available for settlement annually 50 to 70 thousand acres of land beginning 4 years hence.

Revenue from the sale of electric power, production of which will begin from two small units in December, will pay a substantial part of the irrigation costs, it is anticipated.

Dr. Torbert estimated that about 30,000 families can ultimately be accommodated on the land with employment for twice that number in towns and villages when full development is accomplished. Surveys are now going forward looking to classification and appraisal of land. These, with the studies of social and economic problems, should be completed about 2 years prior to the time the first land is available for settlement, Dr. Torbert explained, thus affording opportunity for guiding the location of settlers.

Central Valley Project

Walker R. Young, supervising engineer, pointed to a 30 percent increase in the past decade in the population in the area to be served by the Central Valley project in connection with an explanation of the objectives of this California undertaking. Since 1930, the population of this area has been augmented by 287,000, made up principally of families who have fled drought areas and increasing to 1,249,000 the number of persons on farms and in urban areas largely dependent on rehabilitation of the water supply.

Mr. Young, who was formerly in charge of the construction of Boulder Dam, told the committee the Central Valley project is designed primarily to insure stabilization of agricultural products, representing an investment of $2,000,000,000. The area is about two-thirds of the irrigated acreage in the Central Valley. More than 50,000 acres have already been abandoned; 400,000 acres in the San Joaquin Valley are threatened, while another 400,000 acres of rich delta lands are menaced by intrusion of salt water from San Francisco Bay. Still other areas are frequently inundated by floods in the Sacramento River which cause great damage.

Supplemental water for irrigation through diversion of surplus Sacramento River water to the San Joaquin Valley is a major objective of the Central Valley project. Other features include improvement of navigation, flood protection, salinity control, improved industrial and domestic supplies and electric-power development. Incidentally, it will bring into production about 175,000 acres of new land, which will be available for settlement. Power sales will pay a large part of the costs of the entire project.

On the farms the project will serve are now 312,000 persons with more than three times that number in the cities and towns—the equivalent of 300,000 families. Only a few of the 70,000 families from the drought or other areas who have migrated into the valleys since 1930, were able to find irrigated land on which to settle. As a result, they have been forced to depend on seasonal agricultural employment or have relied almost wholly on relief.

Mr. Young quoted E. P. Goodrich and C. V. Davis, of the American Society of Civil Engineers, as stressing the suitability of the area for combined industrial and agricultural development with the assurance of a water supply from the Central Valley project.

Dr. Ray Lyman Wilbur, president of Stanford University, was quoted as predicting that the regulated water supply of the Central Valley will "increase our population by several millions."

The present construction program schedules the Central Valley project for completion in 1946. Both Mr. Young and Dr. Torbert emphasized that the progress of the project is dependent on future appropriations from Congress.

H. H. Johnson Assumes New Duties

H. H. JOHNSON, formerly superintendent of the Milk River project, Montana, has been assigned to the position of field supervisor of projects in Montana and northern Wyoming.

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Projects under construction or operated in whole or in part by the Bureau of Reclamation

Project	Office	Official in charge		Chief clerk	District counsel	
		Name	Title		Name	Address
All-American Canal	Yuma, Ariz	Leo J. Foster	Construction engineer	J. C. Thrailkill	R. J. Coffey	Los Angeles, Calif.
Altus	Altus, Okla	Russell S. Lieurance	Construction engineer	Edgar A. Peek	H. J. S. Devries	El Paso, Tex.
Belle Fourche	Newell, S. Dak	F. C. Youngblutt	Superintendent		W. J. Burke	Billings, Mont.
Boise	Boise, Idaho	R. J. Newell	Construction engineer	Robert B. Smith	B. E. Stoutemyer	Portland, Oreg.
Boulder Canyon [1]	Boulder City, Nev	Irving C. Harris	Director of power	Gail H. Baird	R. J. Coffey	Los Angeles, Calif.
Buffalo Rapids	Glendive, Mont	Paul A. Jones	Construction engineer	Edwin M. Bean	W. J. Burke	Billings, Mont.
Buford-Trenton	Williston, N. Dak	Parley R. Neeley	Resident engineer	Robert L. Newman	W. J. Burke	Billings, Mont.
Carlsbad	Carlsbad, N. Mex	L. E. Foster	Superintendent	E. W. Shepard	H. J. S. Devries	El Paso, Tex.
Central Valley	Sacramento, Calif	W. R. Young	Supervising engineer	E. R. Mills	R. J. Coffey	Los Angeles, Calif.
Shasta Dam	Redding, Calif	Ralph Lowry	Construction engineer		R. J. Coffey	Los Angeles, Calif.
Friant division	Friant, Calif	R. B. Williams	Construction engineer		R. J. Coffey	Los Angeles, Calif.
Delta division	Antioch, Calif	Oscar G. Boden	Construction engineer		R. J. Coffey	Los Angeles, Calif.
Colorado-Big Thompson	Estes Park, Colo	Porter J. Preston	Supervising engineer	C. M. Voyen	J. R. Alexander	Salt Lake City, Utah.
Colorado River	Austin, Tex	Ernest A. Moritz	Construction engineer	William F. Sha	H. J. S. Devries	El Paso, Tex.
Columbia Basin	Coulee Dam, Wash	F. A. Banks	Supervising engineer	C. B. Funk	B. E. Stoutemyer	Portland, Oreg.
Deschutes	Bend, Oreg	D. S. Stuver	Construction engineer	Nohle O. Anderson	B. E. Stoutemyer	Portland, Oreg.
Gila	Yuma, Ariz	Len J. Foster	Construction engineer	J. C. Thrailkill	R. J. Coffey	Los Angeles, Calif.
Grand Valley	Grand Junction, Colo	W. J. Chiesman	Superintendent	Emil T. Ficenec	J. R. Alexander	Salt Lake City, Utah.
Humboldt	Reno, Nev	Floyd M. Spencer	Construction engineer [2]		J. R. Alexander	Salt Lake City, Utah.
Kendrick	Casper, Wyo	Irvin J. Matthews	Construction engineer [2]	George W. Lyle	W. J. Burke	Billings, Mont.
Klamath	Klamath Falls, Oreg	B. E. Hayden	Superintendent	W. I. Tingley	B. E. Stoutemyer	Portland, Oreg.
Milk River	Malta, Mont	Herold W. Genger	Superintendent	E. E. Chabot	W. J. Burke	Billings, Mont.
Minidoka	Burley, Idaho	Stanley R. Marean	Superintendent	G. C. Patterson	B. E. Stoutemyer	Portland, Oreg.
Minidoka Power Plant	Rupert, Idaho	S. A. McWilliams	Resident engineer		B E. Stoutemyer	Portland, Oreg.
Mirage Flats	Hemingford, Nebr	Denton J. Paul	Construction engineer		W. J. Burke	Billings, Mont.
Moon Lake	Provo, Utah	E. O. Larson	Construction engineer	Francis J. Farrell	J. R. Alexander	Salt Lake City, Utah
North Platte	Guernsey, Wyo	C. F. Gleason	Superintendent of power	A. T. Stimpfig	W. J. Burke	Billings, Mont.
Ogden River	Provo, Utah	E. O. Larson	Construction engineer	Francis J. Farrell	J. R. Alexander	Salt Lake City, Utah.
Orland	Orland, Calif	D. L. Carmody	Superintendent	W. D. Funk	R. J. Coffey	Los Angeles, Calif.
Owyhee	Boise, Idaho	R. J. Newell	Construction engineer	Robert B. Smith	B. E. Stoutemyer	Portland, Oreg.
Parker Dam Power	Parker Dam, Calif	E. C. Koppen	Construction engineer	George B. Snow	R. J. Coffey	Los Angeles, Calif.
Pine River	Vallecito, Colo	Charles A. Burns	Construction engineer	Frank E. Gawn	J. R. Alexander	Salt Lake City, Utah.
Provo River	Provo, Utah	E. O. Larson	Construction engineer	Jos. P. Siebeneicher	J. R. Alexander	Salt Lake City, Utah.
Rapid Valley	Rapid City, S. Dak	Horace V. Hubbell	Construction engineer	Francis J. Farrell	W. J. Burke	Billings, Mont.
Rio Grande	El Paso, Tex	L. R. Fiock	Superintendent	H. H. Berryhill	H. J. S. Devries	El Paso, Tex.
Elephant Butte Power Plant	Elephant Butte, N. Mex	C. O. Dale	Acting resident engineer	H. H. Berryhill	H. J. S. Devries	El Paso, Tex.
Riverton	Riverton, Wyo	H. D. Comstock	Superintendent	C. B. Wentzel	W. J. Burke	Billings, Mont.
Shoshone	Powell, Wyo	L. J. Windle	Superintendent [2]	L. J. Windle [2]	W. J. Burke	Billings, Mont.
Heart Mountain division	Cody, Wyo	Walter F. Kemp	Construction engineer	L. J. Windle [2]	W. J. Burke	Billings, Mont.
Sun River	Fairfield, Mont	A. W. Walker	Superintendent		W. J. Burke	Billings, Mont.
Truckee River Storage	Reno, Nev	Floyd M. Spencer	Construction engineer [2]		J. R. Alexander	Salt Lake City, Utah.
Tucumcari	Tucumcari, N. Mex	Harold W. Mutch	Resident engineer	Charles L. Harris	H. J. S. Devries	El Paso, Tex.
Umatilla (McKay Dam)	Pendleton, Oreg	C. L. Tice	Reservoir superintendent		B. E. Stoutemyer	Portland, Oreg.
Uncompahgre: Repairs to canals	Montrose, Colo	Herman R. Elliott	Construction engineer [2]	Ewalt P. Anderson	J. R. Alexander	Salt Lake City, Utah.
Upper Snake River Storage [3]	Ashton, Idaho	I. Donald Jerman	Construction engineer [2]	Emmanuel V. Hillius	B. E. Stoutemyer	Portland, Oreg.
Vale	Vale, Oreg	C. C. Ketchum	Superintendent		B. E. Stoutemyer	Portland, Oreg.
Yakima	Yakima, Wash	J. S. Moore	Superintendent	Conrad J. Ralston	B. E. Stoutemyer	Portland, Oreg.
Roza division	Yakima, Wash	Charles E. Crownover	Construction engineer	Alex S. Harker	B. E. Stoutemyer	Portland, Oreg.
Yuma	Yuma, Ariz	C. B. Elliott	Superintendent	Jacob T. Davenport	R. J Coffey	Los Angeles, Calif.

[1] Boulder Dam and Power Plant.

[2] Acting.

[3] Island Park and Grassy Lake Dams.

Projects or divisions of projects of Bureau of Reclamation operated by water users

Project	Organization	Office	Operating official		Secretary	
			Name	Title	Name	Address
Baker	Lower Powder River irrigation district	Baker, Oreg	A. Oliver	President	Marion Hewlett	Keating.
Bitter Root [4]	Bitter Root irrigation district	Hamilton, Mont	G. R. Walsh	Manager	Elsie W. Oliva	Hamilton.
Boise [1]	Board of Control	Boise, Idaho	Wm. H. Tuller	Project manager	L. P. Jensen	Boise.
Boise [1]	Black Canyon irrigation district	Notus, Idaho	Chas. W. Holmes	Superintendent	L. M. Watson	Notus.
Burnt River	Burnt River irrigation district	Huntington, Oreg	Edward Sullivan	President	Harold H. Hursh	Huntington.
Frenchtown	Frenchtown irrigation district	Frenchtown, Mont	Tom Sheffer	Superintendent	Ralph P. Scheffer	Huson.
Fruitgrowers Dam	Orchard City irrigation district	Austin, Colo	S. F. Newman	Superintendent	A. W. Lanning	Austin.
Grand Valley, Orchard Mesa [3]	Orchard Mesa irrigation district	Grand Junction, Colo	Jack H. Naeve	Superintendent	G. J. McCormick	Grand Jctn.
Humboldt	Pershing County water conservation district	Lovelock, Nev	Roy F. Meffley	Superintendent	G. H. Jones	Lovelock.
Huntley [4]	Huntley Project irrigation district	Ballantine, Mont	E. E. Lewis	Manager	H. S. Elliott	Ballantine.
Hyrum [3]	South Cache W. U. A	Logan, Utah	H. Smith Richards	Superintendent	Harry C. Parker	Logan.
Klamath, Langell Valley [1]	Langell Valley irrigation district	Bonanza, Oreg	Chas. A. Revell	Manager	Chas. A. Revell	Bonanza.
Klamath, Horsefly [1]	Horsefly irrigation district	Bonanza, Oreg	Benson Dixon	President	Dorothy Eyers	Bonanza.
Lower Yellowstone [4]	Board of Control	Sidney, Mont	Axel Persson	Manager	Axel Persson	Sidney.
Milk River: Chinook division [4]	Alfalfa Valley irrigation district	Chinook, Mont	A. L. Benton	President	R. H. Clarkson	Chinook.
	Fort Belknap irrigation district	Chinook, Mont	H. B. Bonebright	President	L. V. Bogy	Chinook.
	Zurich irrigation district	Chinook, Mont	C. A. Watkins	President	H. M. Montgomery	Chinook.
	Harlem irrigation district	Harlem, Mont	Thos. M. Everett	President	R. L. Barton	Harlem.
	Paradise Valley irrigation district	Zurich, Mont	C. J. Wurth	President	J. F. Sharples	Zurich.
Minidoka: Gravity [1]	Minidoka irrigation district	Rupert, Idaho	Frank A. Ballard	Manager	O. W. Paul	Rupert.
Pumping	Burley irrigation district	Burley, Idaho	Hugh L. Crawford	Manager	Frank O. Redfield	Burley.
Gooding [1]	Amer. Falls Reserv. Dist. No. 2	Gooding, Idaho	S. T. Baer	Manager	Ida M. Johnson	Gooding.
Moon Lake	Moon Lake W. U. A	Roosevelt, Utah	H. J. Allred	President	Louie Galloway	Roosevelt
Newlands [2]	Truckee-Carson irrigation district	Fallon, Nev	W. H. Wallace	Manager	H. W. Emergy	Fallon
North Platte: Interstate division [4]	Pathfinder irrigation district	Mitchell, Nebr	T. W. Parry	Manager	Flora K. Schroeder	Mitchell.
Fort Laramie division [4]	Gering-Fort Laramie irrigation district	Gering, Nebr	W. O. Fleenor	Superintendent	C. G. Klingman	Gering.
Fort Laramie division [4]	Goshen irrigation district	Torrington, Wyo	Floyd M. Roush	Superintendent	Mary E. Harrach	Torrington
Northport division [4]	Northport irrigation district	Northport, Nebr	Mark Iddings	Manager	Mabel J. Thompson	Bridgeport
Ogden River	Ogden River W. U. A	Ogden, Utah	David A. Scott	Superintendent	Wm. P. Stephens	Ogden.
Okanogan [1]	Okanogan irrigation district	Okanogan, Wash	Nelson D. Thorp	Manager	Nelson D. Thorp	Okanogan
Salt River [2]	Salt River Valley W. U. A	Phoenix, Ariz	H. J. Lawson	Superintendent	F. C. Henshaw	Phoenix.
Sanpete: Ephraim division	Ephraim Irrigation Co	Ephraim, Utah	Andrew Hansen	President	John K. Olsen	Ephraim.
Spring City division	Horseshoe Irrigation Co	Spring City, Utah	Vivian Larson	President	James W. Blain	Spring City
Shoshone: Garland division [4]	Shoshone irrigation district	Powell, Wyo	Paul Nelson	Irrigation superintendent	Harry Barrows	Powell.
Frannie division [4]	Deaver irrigation district	Deaver, Wyo	Floyd Lucas	Manager	R. J. Schwendiman	Deaver.
Stanfield	Stanfield irrigation district	Stanfield, Oreg	Leo F. Clark	Superintendent	F. A. Baker	Stanfield.
Strawberry Valley	Strawberry Water Users' Assn	Payson, Utah	S. W. Grotegut	President	E. O. Breeze	Payson.
Sun River: Fort Shaw division [4]	Fort Shaw irrigation district	Fort Shaw, Mont	C. L. Bailey	Manager	G. L. Bailey	Fort Shaw
Greenfields division	Greenfields irrigation district	Fairfield, Mont	A. W. Walker	Manager	H. P. Wangen	Fairfield.
Umatilla, East division [1]	Hermiston irrigation district	Hermiston, Oreg	E. D. Martin	Manager	Enos D. Martin	Hermiston.
West division [1]	West Extension irrigation district	Irrigon, Oreg	A. C. Houghton	Manager	A. C. Houghton	Irrigon.
Uncompahgre [2]	Uncompahgre Valley W. U. A	Montrose, Colo	Jesse R. Thompson	Manager	H. D. Galloway	Montrose.
Upper Snake River Storage	Fremont-Madison irrigation district	St. Anthony, Idaho	H. C. Fuller	President	John T. White	St. Anthony.
Weber River	Weber River W. U. A	Ogden, Utah	D. D. Harris	Manager	D. D. Harris	Ogden.
Yakima, Kittitas division [1]	Kittitas reclamation district	Ellensburg, Wash	G. G. Hughes	Manager	O. L. Sterling	Ellensburg.

[1] B. E. Stoutemyer, district counsel, Portland, Oreg.

[2] R. J. Coffey, district counsel, Los Angeles, Calif.

[3] J. R. Alexander, district counsel, Salt Lake City, Utah.

[4] W. J. Burke, district counsel, Billings, Mont.

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SALLIE A. B. COE, *Editor.*

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THE RECLAMATION ERA

NOVEMBER 1940

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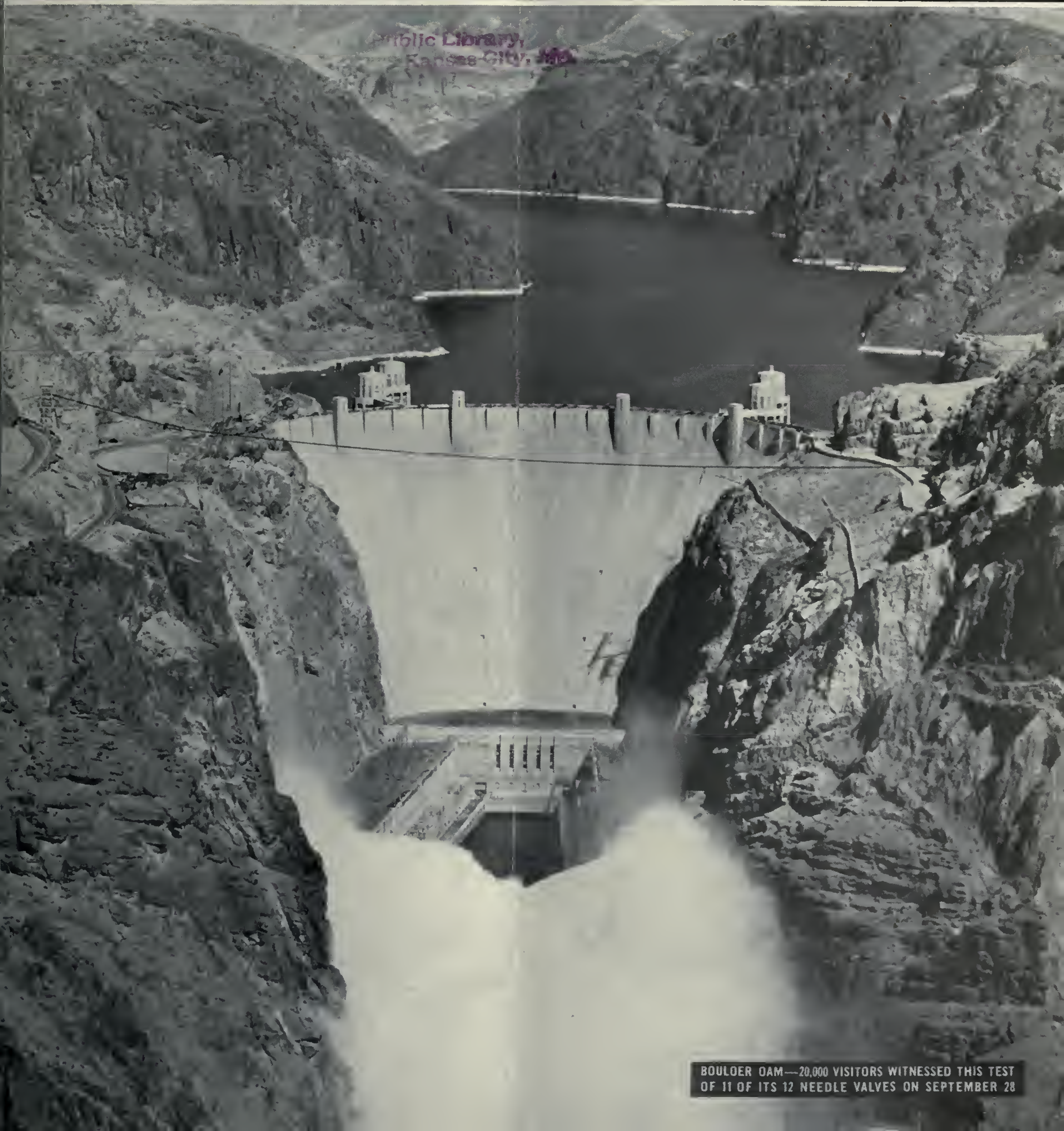

BOULDER DAM—20,000 VISITORS WITNESSED THIS TEST OF 11 OF ITS 12 NEEDLE VALVES ON SEPTEMBER 28

President Roosevelt Greets National Reclamation Association Convention

TO a very serious minded convention of reclamationists from 17 Western States which convened in Great Falls, Mont., September 24–26, President Roosevelt sent the following message:

"It is with pleasure that on the occasion of the ninth annual convention of the National Reclamation Association I again send greetings to those western leaders who are interested in the promotion of sound programs for water and land conservation.

"In grave times it is important that we do not permit our attention to be distracted from our long-range plans for a better America. It is important that, consistent with the efforts that must be made for national defense, we do not permit the disruption of work essential to those long-range plans. Conservation of our resources is a part of that program. The United States in another day will be stronger because of such conservation works as Grand Coulee Dam and its counterparts on numerous smaller streams, stronger because of the power that will flow from them, stronger because of the stable homes which will be founded on the land they will irrigate, and stronger because of the great new wealth that they will create. We must conserve, guard ourselves today, and continue to build for tomorrow."

PRICE
ONE
DOLLAR
A YEAR

THE RECLAMATION ERA

VOLUME 30 • NOVEMBER 1940 • NUMBER 11

National Reclamation Association Convention

A LARGE and enthusiastic group of reclamationists from 17 Western States gathered at Great Falls, Mont., September 24 for a 3-day session devoted to their interests.

The appreciation by the group of their president, O. S. Warden, was expressed in his unanimous election for a sixth term as president of the association, and further expression was given to this sentiment by the surprise presentation of a plaque. The presentation was made by Robert W. Sawyer. It is elaborately printed and framed and is signed by Governor Ayers of Montana, association directors, and Secretary-Manager Hagie. It reads:

"A testimonial of appreciation presented to Oliver Sherman Warden by the 17 States of the National Reclamation Association assembled in annual convention on this 24th day of September in the year 1940.

"True pioneer of Montana and western America; substantial, unselfish servant of public good in community and nation through more than half a century; unfalteringly courageous thinker and molder of public thought; aggressive advocate of improved highway and aviation facilities; persevering protagonist of water conservation as a sound policy, virile, indefatigable force for reclamation as a national betterment; wise, foresighted, tactful counselor and leader; five-time president of the National Reclamation Association—

"In recognition of these first five epochmaking years of service, this grateful acknowledgment, as a sincere personal tribute from innumerable friends in 17 States, is herewith tendered with respectful affection to Oliver Sherman Warden."

Others reelected by acclamation were Ora Bundy, Ogden, Utah, first vice president; Robert W. Sawyer, Bend, Oreg., second vice president; and J. A. Ford, Spokane, Wash., treasurer. The directors of the association, made up of one member from each of the 17 States having membership in the association, unanimously reelected Floyd O. Hagie, secretary-manager.

Another highlight of the convention was the honor paid to three "grand old men" of reclamation, E. F. Blaine, 83, of Grandview, Wash.; I. D. O'Donnell, 80, of Billings, Mont.; and R. E. Shepherd, 80, of Jerome, Idaho. All three men started in irrigation before the Reclamation law of 1902 was passed. Mr. Blaine has been a constant delegate to irrigation and reclamation meetings all over the West ever since he attended his first one in Colorado Springs in 1903 or 1904, and he has devoted his entire adult life to the promotion of western irrigation. Mr. O'Donnell began irrigating in 1882, helped found the National Irrigation Association in the nineties, and aided for 10 years to secure the enactment of the Reclamation law. He, like Mr. Blaine, is an ardent "conventionist," having attended every convention of the Federal Irrigation Congress for 48 years. Mr. Shepherd is chairman of the board of directors of the North Side Twin Falls project near Jerome. He is a former Montanan and began his career in the cattle business there. His active interest in reclamation began in 1896 when, with the help of professors at Bozeman, Mont., he planned the first irrigation ditches for the Flying U Ranch.

Phoenix, Ariz., was selected by the convention as the 1941 convention city.

Seventeen resolutions adopted are digested as follows:

No. 1.—*Resolved by this association,* That the Congress of the United States is urged to provide through proper legislation for the progressive, orderly expansion of the production of beet sugar within the United States and to maintain the beet sugar industry on a reasonable income basis by quota regulations and adequate tariffs on foreign sugar.

No. 2.—*Resolved,* That this association recommends that authorizations for projects be not further delayed during the present emergency where the immediate security of established agricultural communities may be involved and where local participation in the costs thereof is assured.

No. 3.—Whereas the economic life of the people depends largely upon available and usable water resources, and the reclamation policy is based on the multiple use of our water resources, for irrigation, flood control, power, grazing, domestic and industrial water supplies, and the abatement of stream pollution, and

Whereas no dams or reservoirs for the storage of water can be constructed in any national park, and the enormous increase in national parks, and national park areas, particularly in the public land States, constitutes a direct threat to the economic life of our people, not only in respect to water resources, but also as to the use of such areas for forestry, mining, grazing, wild life, and highways: Now, therefore, be it

Resolved, That the National Reclamation Association opposes the creation of any new national parks, monuments, or recreation areas, or additions to those now existing, except with the consent of the legislatures of the States concerned; and, further, it opposes the enactment of H. R. 9351, or any other measure which would authorize the President of the United States, in his discretion, to transfer by Executive order virtually any or all of the unreserved or unappropriated lands to national park status, thereby prohibiting the use of such areas for water, timber, minerals, grazing or highway purposes, and locking up the areas exclusively for recreation, educational, and inspirational purposes.

No. 4.—Whereas the National Reclamation Association at its eighth annual convention in Denver, Colo., in November 1939, called attention to the handicaps under which the Bureau of Reclamation operates through limitations on appropriations that may be expended in the District of Columbia, and since this unsatisfactory condition has not been remedied: Therefore, be it

Resolved, That the National Reclamation Association reaffirms the position taken in the resolution referred to and urges prompt action to the end that restrictions on appropriations for personnel services in the District of Columbia shall be removed so that there shall be sufficient flexibility in the office of the Commissioner of Reclamation to enable it to discharge promptly the additional administrative duties imposed by recent legislation.

No. 5.—Whereas Federal Reclamation, through its incidental activities such as power production, paves the way for advantageously processing minerals of the West that are vital to the national defense for which the country has depended upon foreign sources, and for the operation of essential industries; and

Whereas agricultural production through reclamation assures the nation of adequate food supplies, including such commodities as sugar and wool for which the country has been largely dependent on ocean transportation; and

Whereas * * *: Therefore, be it

Resolved, That the National Reclamation Association reiterates its position that the vigorous promotion and support of national reclamation is necessary for the accomplishment of a complete and coordinated program of national defense.

No. 6.—Whereas in response to Resolution No. 3 adopted at the eighth annual convention of this association in Denver, Colo., in November 1939, some progress has been made in providing personnel for the purpose of advising and instructing settlers regarding irrigation practices; and

Whereas, with the transfer to the Department of the Interior of certain soil conservation duties, there will be further responsibility on the Bureau of Reclamation with respect to conditions on reclamation projects: Therefore, be it

Resolved, That the National Reclamation Association recommends to the Bureau of Reclamation that the staff of irrigation or reclamation advisers be expanded to cover all projects under its jurisdiction and that the Bureau of Reclamation seek the active cooperation of other Federal agencies and of State colleges of agriculture, experiment stations, and other State and local agencies in meeting problems incident to soil and water conservation practices.

No. 7.—Whereas within the Western States, many small reservoirs may be constructed under the Case-Wheeler Act; and

Whereas said act contemplates the use of W.P.A., C.C.C., and other labor in the construction of such projects; and

Whereas the raising of farm products, cattle, sheep, wool, grain, fruits, and food supplies is vitally essential in the interest of national defense; and

Whereas because of increased uses of W.P.A. labor in connection with various Government construction work there is a marked deficiency in the number of men available for work under W.P.A., and

Whereas there is much C.C.C. labor that is not being devoted to purposes of value in the Nation's preparedness program: Now, therefore, be it

Resolved, That the proper governmental agencies be urged to establish camps and to authorize the use of C.C.C. enrollees in the work of construction of dams and otherwise to assist in the development and construction of such reservoirs.

No. 8.—Whereas the 1940 census reports show the disastrous effects of continued drought on the economy of the Great Plains and other areas with consequent dislodgment of thousands of rural and nonagricultural families and heavy losses in population in areas without water conservation facilities; and

Whereas these reports reflect the impact of the migration westward of more than 125,000 destitute families; and

Whereas conditions incident to the drought and the migration of destitute families and the lack of presently available irrigated lands of the West upon which to settle the newly arrived families have resulted in raising Federal relief expenditures in the 17 States of the West in the last 7 years to more than 2½ billion dollars; and

Whereas the Weather Bureau and other official reports show the drought has not been broken and that westward migrations are continuing; and

Whereas completion of the Federal Reclamation program as now authorized with reimbursable funds and its expansion to meet critical situations in the Great Plains and elsewhere will require in 10 years an amount less than one-fourth of the Federal relief expenditures in these States: Therefore be it

Resolved, That the National Reclamation Association in its ninth annual convention urgently recommends:

1. That in order to anchor rural and nonagricultural families in their present locations in the Great Plains and other areas and to reduce the necessity for further migrations, the Case-Wheeler Act (Public 398, 76th Cong., 1st Sess.) be implemented with an annual appropriation of reimbursable funds of $10,000,000, to be supplemented by labor and materials from C.C.C. camps and other Federal agencies, including direct and indirect relief agencies, for the construction of water conservation projects.

2. That in order to provide irrigated land promptly for migrant farm families and to stabilize established communities threatened by inadequate water supplies and the continual loss of population the current reclamation program be provided with appropriations of reimbursable funds at a rate of approximately $75,000,000 a year.

3. That in order that there may be available to the Federal Government and the arid and semiarid land States a complete inventory of unused water supplies and information as to ways and means by which they may be utilized for the national benefit, the Bureau of Reclamation shall be provided with not less than $1,000,000 annually for investigations.

No. 9.—Whereas, the forest lands serve fundamentally as Nature's reservoir, helping to regulate streams, reducing damaging floods and erosion, sustaining underground water supplies, and contributing immeasurably to western Reclamation; and

Whereas due to lack of funds in the face of rapidly expanding duties the Forest Service finds it impossible to fully administer the areas now under its direction, particularly with reference to fire control, disease control, range improvements, reforestation, and other activities related to water conservation; and

Whereas in the opinion of this association a material increase in the appropriations for the Forest Service to cover these phases of its operation would constitute an essential investment to protect the interest of western areas and preserve their natural resources: Now, therefore, be it

Resolved, That this association request adequate appropriations to enable the Forest Service to administer its operations upon a sound and adequate basis.

No. 10.—*Resolved,* That the activities of the

Reelected officers. *Seated, left to right:* O. S. Warden, President; Floyd O. Hagie, Secretary-Manager. *Standing, left to right:* J. A. Ford, Treasurer; Robert W. Sawyer, Second Vice President; and Ora Bundy, First Vice President

National Resources Planning Board sponsoring orderly, comprehensive, and basin-wide water development and a program of drainage basin committees which bring together local, State, and Federal agencies, be approved and the necessity for continuance of such work recognized.

No. 11.—*Resolved,* That the National Reclamation Association recommend to Congress the appropriation of a sufficient sum of money to make a comprehensive study of noxious weed control on Forest Reserves, Grazing Reserves, and Reclamation projects.

No. 12.—Whereas many existing projects, financed in whole or in part by Federal funds, are in need of canal and works betterments; of replacement of structures, of additional storage and other work necessary to make adequate the supply of water for their projects, the cost of which is beyond the ability of the projects to raise, and

Whereas the difficulties of these projects reflect upon the success of reclamation and prevent proper profits to those projects: Now, therefore, be it

Resolved, That the National Reclamation Association asks that a study of the needs of existing projects be made and that a program of betterments on those projects be formulated to be carried out over a period of several years of time to go hand in hand with work on new projects in Reclamation States.

No. 13.—Whereas the Federal Government, in proceedings before the Supreme Court of the United States, has asserted claim to all the unappropriated waters of nonnavigable streams of the Western States, and also that the return flow resulting from the irrigation of Federal Reclamation projects is the property of the Federal Government, and therefore free of the sovereign control and supervision of the States in which such waters and projects are located, which is contrary to the fundamental principles of water laws in these several Western States;

Whereas, section 8 of the Reclamation Act contains a definite and specific provision requiring compliance with the water laws and recognizes vested rights acquired thereunder; and

Whereas Federal judicial decisions affirm that sovereignty over such waters is vested in the States and not in the United States; and

Whereas, the Flood Control Act of June 28, 1938, and later acts authorizing the construction of certain public works on rivers for flood control and other purposes; the Pope-Jones Act, otherwise known as the Water Facilities Act, authorizing the construction of water conservation and utilization projects in the Great Plains and arid and semiarid regions of the United States; the Case-Wheeler Act; the Taylor Grazing Act; and possibly other acts authorizing the construction by Federal agencies of works for the control and use of waters in the Western States, contain no statement that the activities of the Federal Government, under the provisions of the various Federal acts, shall be carried out in conformity with State law covering the ownership, control, and use of the waters of these Western States: Now, therefore, be it

The 3 "Grand Old Men." *Left to right:* E. F. Blaine, I. D. O'Donnell, R. E. Shepherd

Resolved, That the National Reclamation Association recommends and reaffirms and strongly urges that these several acts, and all similar acts, be amended at the earliest posible date to include provisions requiring that in the prosecution of all works designed for water conservation and use the particular Federal agency or department involved, shall, in all respects, comply with State laws relating to the ownership, control, administration, and use of the waters of these Western States.

Resolved, That * * *; and be it further

Resolved, That all Federal agencies constructing works of any nature for the conservation and use of water within the member States of this association be advised of the necessity of observing the laws of the respective States governing the appropriation, storage, and use of water; and that no structures or series of structures, however small, built for the use of water be constructed without consulting the appropriate State administrative officials concerning the necessary requirements of the State law respecting the same. * * *

No. 14.—Whereas there was passed by the National Congress in 1937, the Pope-Jones Bill, known as the Water Facilities Act, authorizing the Secretary of Agriculture to plan, construct, or cause to be constructed, small facilities for water conservation projects, for irrigation and other agricultural purposes; and

Whereas the scope of duties of the agencies administering this act has been so broadened as to include the rehabilitation of irrigation projects not only in reconstruction and betterments to irrigation works, but also the financial consolidation of indebtedness under a Government loan at a low rate of interest; and

Whereas the efficiency of these agencies has been increased and more coordination is exercised between them, to the end that more definite results are obtained within a reasonable time; and

Whereas these agencies are servicing a class of projects that are in dire need of physical and financial aid that is and cannot be reached by any other Government agency: Now, therefore, be it

Resolved, That we recommend the continuance of the Water Facilities Act program with sufficient funds available, whereby small loans may be obtained by worthy borrowers not only for the rehabilitation of existing projects, but also for the construction of new facilities for providing supplemental water on lands now inadequately irrigated.

No. 15.—*Be it resolved,* That this association hereby expresses its endorsement of and appreciation to the United States Geological Survey for its topographic surveys and for the systematic collection and publication of basic information on surface and ground water resources, essential to development, use and control thereof, which during this period of national emergency are of particular importance to the welfare of our country; and be it further

Resolved, That this association urge adequate appropriations by the Congress and the State legislatures to permit the continuation and extension of this important work upon the cooperative basis now existing; and that this association urge that Federal appropriations be increased to meet national needs in expanding the network of strictly Federal gaging stations and observation wells.

No. 16.—Whereas interstate litigation over waters of interstate rivers on which irrigation is dependent requires enormous expenditures of public monies and results in long delays with an impairment of necessary water development and in decrees which often ripen into further and prolonged litigation; and such procedure is unsatisfactory from a practicable standpoint to the water user; and

Whereas the principles controlling the equitable apportionment of waters of an interstate river have been well settled by the Supreme Court of the United States; and engineering investigation of all pertinent facts by an impartial, competent agency for the purpose of determining all factors necessary for the consideration of equitable apportionment of the waters of such rivers is of paramount importance; and

Whereas the settlement of interstate river controversies by compact based upon adequate engineering investigation has proved more satisfactory, basically sound and in the interest of the water user: Now, therefore, be it

Resolved, That in all cases involving interstate river controveries where no adjudication exists an attempt be first made by the interested States to reach equitable adjustment by compact based upon adequate joint engineering studies and investigations by competent and impartial agencies; and that litigation be initiated only as a last resort.

No. 17.—Whereas the reclamation of the arid West is a Federal problem, and

Whereas in addition to the projects which have been financed directly by the Federal Bureau of Reclamation there are many other irrigation projects which represent an acreage equal to or greater than Federal Reclamation projects which have been financed or refinanced by other Federal agencies, and are now paying interest on construction costs at a rate of 4 percent per annum and amortized in 30 years, and

Whereas reclamation projects and irrigation projects financed by other Federal agencies are generally contiguous and adjacent to reclamation projects and are producing similar crops at comparable production costs: Now, therefore, be it

Resolved, That this association endorse and recommend the enactment of Federal legislation providing for a more equitable rate of interest and amortization payments on such projects.

Interstate Migrations Investigations

At the invitation of Representative John H. Tolan of California, chairman of a special congressional committee investigating interstate migrations, Bureau of Reclamation officials discussed with the committee at two hearings in the West in September, major features of the Reclamation program and related matters.

Commissioner Page at Lincoln, Nebr., on September 17 emphasized effects of continued droughts in accelerating migrations from the Great Plains and the resulting pressure of population on irrigated areas to the westward. He cited the contribution Reclamation is making to stabilization of the West and the settlement and employment opportunities that will be afforded if appropriations for construction are continued at the present rate. Census records were cited showing an increase in population of the irrigation States twice the average for the country.

E. B. Debler, hydraulic engineer, Denver office, presented at Lincoln results of recent preliminary investigations of unused water supplies west of the 100th meridian. These indicated the supply is sufficient to irrigate 22,000,000 additional acres and provide a firm supply for 11,700,000 acres presently irrigated which will require supplemental water. A total of 428,000 new family-size farms could ultimately be created.

At San Francisco on September 25, Walker R. Young, supervising engineer, detailed the objectives of the Central Valley project. Impact of migrations has been specially heavy in this area. On the same day at San Francisco, Dr. E. N. Torbert, field coordinator, Columbia Basin project, explained investigations under way in connection with planning the settlement of the areas to be irrigated by Grand Coulee Dam.

Because of the importance of solutions of the migrant problem to the development of irrigation in the West, the statements presented by Commissioner Page and Mr. Debler are reproduced in this issue of the ERA.

Reclamation Offers Solution for Migrant Farmer Problem in the West

By JOHN C. PAGE, *Commissioner of Reclamation* [1]

DROUGHTS have visited the Great Plains region periodically. One between 1886 and 1895 accelerated demands for participation by the Federal Government in conservation of the scanty water supplies of the arid and semiarid lands of the West, and in so doing influenced the adoption of the national irrigation policy embodied in the Federal Reclamation Act of June 17, 1902.

It might be well at the outset to outline briefly the conditions existing in the West which make irrigation necessary and to review the work which has been done under our historic Federal Reclamation policy.

The 100th meridian makes a north and south line on the map of the United States through the States of North and South Dakota, Nebraska, Kansas, Oklahoma, and Texas, passing near Bismarck, N. Dak., and Pierre, S. Dak., and between North Platte and Kearney, Nebr. East of this line the rainfall generally exceeds 20 inches annually and is sufficient for crop production. West of the line, except for high mountains and a narrow strip along the northern Pacific coast the rainfall generally is 20 inches or less, insufficient for normal crop production. In this western arid and semiarid section are 153,600,000 acres of land which on the average receive less than 10 inches of rain a year, and 588,700,000 acres which receive between 10 and 20 inches. A total of 39 percent of the land area of the United States, therefore, receives too little rainfall for a safe general agriculture unless water can be supplied artificially by irrigation works.

Since its inception the Bureau of Reclamation has constructed irrigation works to reclaim 2,500,000 acres and to provide a dependable water supply to 1,500,000 acres partially irrigated and settled through other means. On the lands made newly habitable by this construction almost a million persons make their homes on more than 50,000 farms and in some 250 villages and towns which have grown up on these projects. It is notable that these results have been achieved by the expenditure of about $250,000,000, all of which is reimbursable, contracts with the water users having been written under which the cost of the construction will be returned to the United States without interest.

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[1] Statement made at Lincoln, Nebr., September 17, 1940, before Special Committee of House of Representatives, investigating interstate migration of destitute citizens.

These States of the high plains were settled originally under the homestead laws which embodied a land settlement policy appropriate in the humid areas but wholly inadequate to the needs of the semiarid and arid territories. Men of vision who were familiar with the western country pointed out the inadequacy of the homestead laws and the need for some other plan of settlement and development based on integration of grazing and irrigation. The change in policy, however, was not made until much too late to prevent the creation of the problem we now face in the Great Plains.

By 1886, when the drought mentioned at the opening of this statement set in, much land had been plowed in the high plains and during the trying years which followed, thousands of families migrated. They did but join the multitudes which were streaming west to a frontier which still was open, and their tragedies mingled and were lost in a greater drama. By 1902, when the Reclamation Law was enacted, it was generally recognized that irrigation was essential to general farming in the arid and semiarid region and for close settlement of any considerable part of the West. The recognition of these facts and the institution of a Federal irrigation program, however, did not prevent expansion of settlement in the Great Plains during a later series of wet years and under the spur of wartime prices for wheat. When in 1930 the extended and critical drought which still is with us set in in this region, the stage thus had been set for a greater human tragedy.

The impact of the drought on the people of the Great Plains and of other western areas was indeed staggering. Like oak leaves in an autumn wind, some held on more firmly than others, but with the first blast a few were scattered and as the storm rose and fell there were flurries of those that had been shaken loose. The great dust storms of 1934 which threw a pall over all of eastern United States, together with the stream of jalopy caravans on the highways, brought a realization that the agriculture of this region was out of balance with nature, and that major readjustments of land-use programs were overdue.

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It has been most difficult to obtain reliable figures on the number of families that have joined in interstate migrations as a result of the drought. In some areas there have been other influences, such as mechanization of cotton plantations. Others who have made original studies of this question may provide the best information. I have made some investigations, however, which may be pertinent. For the first time in the history of the States of this region, the 1940 census is showing a net loss in population in the Great Plains area. The accompanying tabulation is self-explanatory, and no doubt will be of interest in this connection.

Loss of population in Great Plains,[1] *1930–40*

State	Number of counties	Counties showing decreases	Net loss in population	Percentage of decrease
Kansas	105	90	82, 184	4. 4
Nebraska	93	77	64, 495	4. 7
North Dakota	53	43	41, 155	6. 0
Oklahoma	77	48	61, 603	2. 6
South Dakota	69	61	52, 877	7. 6
Total	397	319	302, 314	------

[1] Preliminary census reports indicate that a majority of the 101 counties in western Texas classified as in the Great Plains States showed losses in population. Practically all nonirrigated counties in the eastern parts of Montana, Wyoming, Colorado, and New Mexico, counted as part of the Great Plains, likewise showed decreases.

While the increase in population for the United States as a whole in the decade covered by the 1940 census will approximate 6.5 percent, the increase in the population of the 11 Mountain and Pacific States, generally considered the Irrigation States, apparently will approximate 13 percent or more. It is especially significant, therefore, that in typical counties devoted to dry farming in the Western States the 1940 census shows substantial losses in population during the 10-year period of drought.

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In 1900 Scottsbluff County had 2,552 residents and was largely devoted to dry farming and cattle raising. The North Platte project was begun in 1905. By 1910 the population of Scottsbluff County had increased to 8,355; by 1920 to 20,710; by 1930 to 28,644 and through the 10-year drought by 1940 to 33,875, a gain of about 13 times. The increase from 1930 to 1940 was 18.3 percent as compared with a net loss for the whole State of Nebraska of 4.7 percent. There are irrigated in Scottsbluff County now 190,000 acres. At least 80 percent of the population there derives its income directly or indirectly from irrigated agriculture. The only industries are those engaged in processing farm products. The city of Scottsbluff, the largest municipality in the county, reflected the stability of the farming area. Its population has increased 41.5 percent in the past 10 years.

* * * * *

A comparison of the population records for irrigation counties in contrast with the records of the dry farm counties is evidence of the importance of irrigation in the development and the secure growth of these Western States.

The drought of the past decade has not been one long, continuous period of no rainfall but rather a period of relatively low rainfall. The significance of this fact is found, in my opinion, in the averages rather than in the extremes of the record. Not all localities afflicted by the drought have suffered with equal severity at all times, and indeed in some areas where the drought has been severe the rainfall in individual years exceeded the long-time average. The deficiency of moisture in the soil and subsoils, however, makes the relief furnished by a year of normal or even abnormal rainfall of short duration. Variations from the normal of 2 or 3 inches in areas where the average rainfall is barely sufficient may bring a disaster of a severity that would not be matched in a more humid region by a drought constituting a variation from the normal for that area of 10 inches.

Recalling now that the census figures show a net loss in population in the Great Plains areas during the decade 1930–40, it is interesting to note that the bulletin The People of the Drought States, issued in 1937 by the Works Progress Administration, showed that the migration from and the migration to (plus the births) the drought areas between 1930 and 1935 were about equal. It is evident that the great migration set in during and after the critical drought of 1934. Not all of the people who left these areas went westward, of course, but between July 1, 1935 and January 1, 1940, more than 180,000 persons from the Great Plains who were "in need of manual employment" were checked at the border patrol stations of California alone.

Well-founded estimates indicate that about 230,000 persons entered the States of Washington, Oregon, and Idaho from the Great Plains in the 10-year period from 1930 to 1940. These estimates do not indicate that the families entering the Pacific Northwest were destitute on leaving the Great Plains, but it may be safely assumed that they had not salvaged much when they abandoned their homes and made the journey westward in the old and second-hand automobiles which cluttered the roads in those years.

* * * * *

Distress necessitated relief measures

The migration of the thirties was attended by widespread distress due to lack of settlement opportunities and of employment. The results have been reflected in the relief burdens on the Federal, State, and local governments. No complete figures are available as to expenditures by other than the Federal Government but these tell a striking story.

During the period from 1933 to July 1, 1940, the Work Projects Administration and its predecessors expended 2½ billion dollars in the 17 States of the arid and semiarid region. Excluding Texas, where less than one-fourth of the population is in the drought area, the outlay was $250,000,000 more than the 1930 population would seem to have justified on a per capita basis.

In South Dakota, where the entire State was affected by the drought, for instance, the excess relief expenditures in the 7-year period were more than $25,000,000. California, where the impact of migrations has been most severe, showed an excess outlay on a population basis of more than $80,000,000.

* * * * *

Few Water Users Required Relief

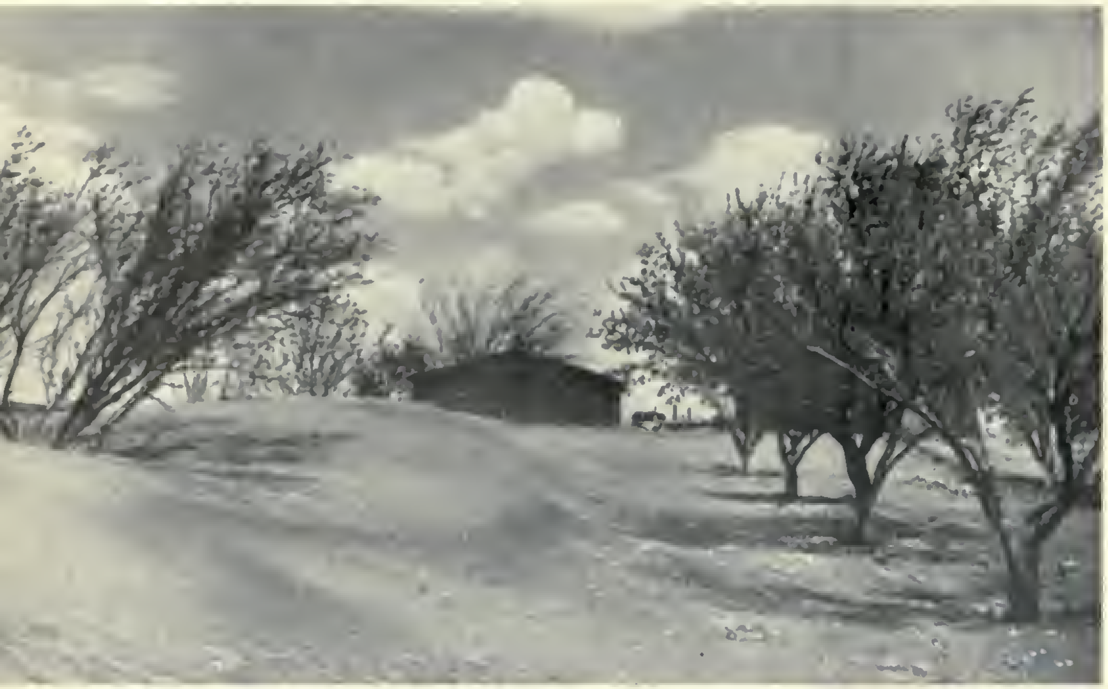
Reports from typical reclamation project areas in 1937 showed that very few water users were on relief and that most of those who did require public assistance were newcomers. In other words, the irrigated areas of the West, generally speaking, supported their normal population while Federal relief expenditures were largely due in these rural areas to the influx of migrant families.

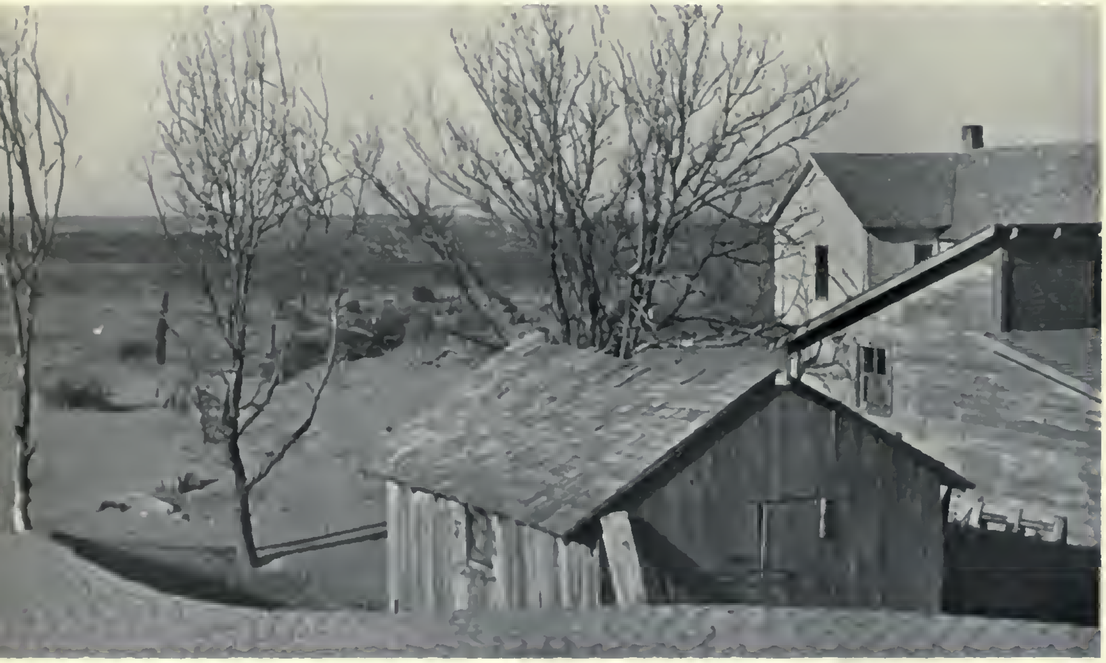
A survey by the Works Progress Administration, in cooperation with the Department of Agriculture, revealed that from 1933 to 1936 the heaviest expenditures in Federal aid of all kinds were in the counties which appeared to be most seriously affected by drought. In 137 counties where the population loss was heaviest, the per capita expenditures for the period averaged $175; in 179 counties, where conditions were less serious, the expenditures averaged $58 per capita.

It is evident that the distress which has resulted from the migrations has necessitated relief expenditures which are at the very least $250,000,000 above what might be called normal requirements. The relief expenditures directly traceable to this cause probably are much higher. It is evident also that a detailed analysis of conditions in the irrigated areas would show that relief expenditures among bona fide farmers there were extremely small.

It is not suggested that if all of the land in the area west of the 100th meridian for which there is water available were under irrigation, the migrations and attendant drain on the Federal Treasury for relief could have been avoided. But in the absence of an adequately implemented water conservation program in the Great Plains and sufficient irrigated land to the westward, relief expenditures were imperative. That course admittedly afforded no permanent solution for the problems here faced.

In this connection it may be pointed out that under the Federal Reclamation program in 38 years there has been expended about $250,000,000 on projects completed and in operation, as distinguished from those under construction. The amount approximates the excess relief expenditures in the past 7 years directly traceable to drought and migrations. When all projects under construction are completed, the cost in reimbursable funds of these





Upper: Sand dunes in an Oklahoma orchard

Center: Soil blown by "Dust Bowl" winds piled up in large drifts on a farm near Liberal, Kans., March 1936

Lower: Adobe farm house of rehabilitation client, Cimarron County, Okla.

Courtesy of Farm Security Administration permanent improvements will be but a little more than half of the Federal relief costs in the area in 7 years.

With an expenditure of about $250,000,000 on a reimbursable basis, the Bureau of Reclamation has actually created homes for about 1 million persons on farms and in project towns. In addition to making these successful homes, the projects have been and will continue to be important sources of new wealth.

These projects also make valuable contributions through assistance in the stabilization of surrounding areas. For example crops valued at $2,657,987,768 have been produced since their beginnings on the projects. On an average, it has been estimated each irrigated acre supports 3 to 4 acres of range land. Thus the 4,000,000 acres for which the Federal irrigation works are prepared to provide with a full or supplemental water supply give value to 12,000,000 to 16,000,000 additional acres.

As a further indication of an important service, I cite the stabilization of local and State governments through creation of taxable wealth. Irrigated land has an assessed valuation in most of the Western States of 10 to 15 times that of adjoining dry land. In eastern Wyoming Federal project land is assessed at an average of more than $30, while unirrigated farm land surrounding it has an assessed valuation of $2.35 an acre. In South Dakota, the valuation of irrigated land for purpose of taxation is $30 an acre and the best dry farm land in the vicinity of a Federal project is assessed at $4.50. The average is much less. In irrigated areas to the westward assessed values, where specialty crops are produced, run as high as $200 or $300 per acre.

The per acre value of crops produced on Federal Reclamation projects from 1931 to 1939 averaged $36.33 compared with a national average of all field and fruit crops in the United States of $14.41. * * *

Federal Reclamation Permanent

Federal Reclamation is not an emergency program, nor can it be used in an emergency through rapid expansion immediately to meet critical developing needs. Construction of a project requires painstaking investigations, for to build a project for which there was insufficient water or on which the lands were not of properly high quality could result only in failure. To build dams and big canals after the project has been approved and authorized also takes time. The Bureau of Reclamation builds for permanence as it feels that its projects will serve indefinitely into the future. For these reasons, the Bu-

Upper: New home built by settlers on a Federal Reclamation project

Center: Reaping oats on the Riverton project, Wyoming

Lower: Irrigating on a Federal Reclamation project reau has had few new farmsteads to offer to the public during these years just past when the need was critical. The expansion of our construction program was coincidental with the drought and the start of these migrations. Since 1930, however, the Bureau has completed facilities to provide a full water supply to 381,000 acres of land, and storage facilities have been completed to provide supplemental water to an additional 304,000 acres already irrigated, but inadequately supplied with water. Thus in this decade more than 15,000 farm families have been settled or made secure.

In advancing the Federal program, which seeks to contribute to a solution of the migrant problem, the Bureau of Reclamation is now engaged in the construction of three types of projects:

First: Those which within the next 10 to 20 years, under present plans, will bring 2,500,000 acres of newly irrigated land into cultivation for the settlement of 40,000 to 50,000 families and which will provide support for an additional 75,000 to 100,000 families in nearby cities and towns. These projects are located in Washington, Oregon, California, Arizona, Utah, Idaho, Colorado, Montana, Oklahoma, and New Mexico.

Second: Projects which will assure supplemental water for 3,900,000 acres of presently developed irrigated areas threatened with desolation by shortages. These undertakings will serve the double purpose of maintaining established communities, agricultural and urban, and, through shifts in agricultural practices, will provide opportunities for settlement and employment of a larger population. There are now about 85,000 farm families on the land covered by these projects and about 250,000 additional families in the urban areas dependent on them.

Third: Water conservation and utility projects which will pave the way in the Great Plains and other arid and semiarid areas for land-use readjustments that will anchor families where they are now located and reduce the necessity for further migrations. Undertakings of this type under construction or for which funds have been provided will, it is estimated, assure rehabilitation of 2,250 farm families who otherwise in all probability would be compelled to join the army of migrants seeking a means of livelihood elsewhere. Although urged for several years as a means of combating conditions incident to the droughts, the fiscal year 1940 saw the first appropriations available for small projects of this type. Those under way are in North and South Dakota, Montana, and Nebraska.

A fourth phase of the Bureau's program is concerned with surveys and investigations of water resources and land available for irrigation. There are now approximately 175 locations in the 17 arid and semiarid States where surveys are going forward or are proposed. Included are about 50 projects in the Great Plains extending from the Canadian border to the Rio Grande.

The most recent estimates show there is water available to irrigate more than 21,000,000 additional acres of productive land in the 17 States of the West. This figure may be more meaningful when compared with the present total of irrigated lands in those States west of the 100th meridian. In irrigation projects of all types there are now about 20,000,000 acres.

Of the 2,500,000 acres included in the new-land projects 580,631 are in public land in the States of California, Arizona, Idaho, Oregon, Washington, and Wyoming.

Congress Approves Policy

From the first, the Congress has looked upon the Federal Reclamation program as conservation activity in which settlement of people was a primary concern. At the outset the policy established in the days of the passage of the homestead laws that ownership should be by family-sized units was applied to reclaimed lands. From time to time other provisions were made, such as the authorization for establishment of qualification requirements for settlers; provisions to prevent speculation in project lands and thereby to protect the interest of the legitimate settler; and a special act permitting the acceptance of credit extended to needy prospective settlers by the Farm Security Administration as fulfillment of capital requirements made on applicants for entry to the new farms. Among the most significant of these, however, is that which was included this year in the Department of the Interior Appropriation bill for 1941 (Public 640, 76th Cong.), which is as follows:

"It is hereby declared to be the policy of the Congress, in opening to entry of newly irrigated public lands, preference shall be given to families who have no other means of earning a livelihood, or who have been compelled to abandon, through no fault of their own, other farms in the United States, and with respect to whom it appears after careful study, in the case of such family, that there is a probability that such family will be able to earn a livelihood on such irrigated lands."

There can be no doubt that it is intended that the Reclamation program shall assist where possible in relocation of the migrant people who are qualified to accept the responsibilities which go with the opportunity to develop new farms by irrigation.

With respect to the projects of the water conservation and utility type especially designed for the Great Plains and similar areas, it is found from estimates of the Farm Security Administration which has the responsibility for settlement of the projects of this type so far authorized for construction, that about 1,100 families can be rehabilitated on each 100,000 acres irrigated by this method. An existence, precarious at best, is provided for families settled only one-third as thickly on typical areas that have been selected for development under the program to date. In addition, it is estimated that 600 families also can be rehabilitated in adjacent dry-land areas by reason of farm unit and population readjustments in the dry-farmed areas thus made possible.

Reimbursable appropriations made for these water conservation and utility projects represent approximately 40 percent of the outlay necessary to construct them and to make the land ready for cultivation. The remainder of the funds is allocated by the President for labor and materials from the Work Projects Administration or other governmental agencies and is not necessarily reimbursable. The authority for projects of this type is contained in the Interior Department Appropriation Act of 1940 (53 Stat. 685) and the Wheeler-Case Act of 1939 (53 Stat. 1418). Amendments to the latter act suggested to the Congress are designed to clarify its provisions and expedite construction.

Under this legislation a total of $8,500,000 of reimbursable appropriations has been made. For construction and land preparation of 10 to 12 projects, $10,000,000 to $12,000,000 additional in labor and materials from the Work Projects Administration or the Civilian Conservation Corps will be required. Much of the latter moneys will be in lieu of relief expenditures on less permanent construction.

A tentative 5-year program submitted by Secretary of the Interior Ickes to Senator Carl Hayden of Arizona, under date of January 18, 1940, outlined 75 small projects in the Great Plains and arid States to the westward designed to anchor farm families at their present locations. Over-all construction costs were estimated at around $60,000,000 with about half to be made available on a reimbursable basis. Water would be supplied for areas on which 8,000 to 10,000 families would be resettled.

What the reclamation programs can accomplish in the next 10 years will be governed by the amount of money made available for this work. However, with appropriations of reimbursable funds continued at the current rate, and with a limited diversion of relief funds for water conservation and utility projects, results that may be expected with confidence at the end of 10 years can be summarized as follows:

1. Forty to fifty thousand farm families already in the West will be settled on irrigated land where they will be self-sustaining.
2. Seventy-five to one hundred thousand additional families will be supported in cities, towns, and villages which will rise or expand in the wake of irrigation developments.
3. Eighty-five thousand farm families in areas now facing shortages of water will be made secure in their present locations, while cities and towns with three times the rural population will be stabilized as well.
4. Twenty to twenty-five thousand families remaining in the Great Plains and similar areas will be rehabilitated.

Stabilization by Irrigation

By E. B. DEBLER, *Hydraulic Engineer, Bureau of Reclamation*[1]

PRELIMINARY reports of the 1940 census show that water conservation is today a greater factor than ever in assuring economic security for the increasing population of areas in the arid and semiarid West where irrigation dominates agricultural production. The fact that so many counties thus classified show substantial gains in population emphasizes the importance of an authoritative inventory of present and potential irrigation development and the influence that it can and will exert as a stabilizing factor.

With respect to irrigation characteristics, the Western United States may be divided into four zones.

Subhumid region.—The most easterly zone occupies a north-south belt of some 200,000,000 acres, with its western border along the 98th meridian. Designated the subhumid area, it is characterized by long periods of years when precipitation is generally adequate in amount and distribution for satisfactory crop production. Grazing is limited to areas unsuited to cultivation. Irrigation receives attention only in periods of protracted drought coming at long intervals and is quickly dropped when rains resume. While water resources are plentiful, even in drought periods, for extensive development, irrigation projects are not justified as they would be deserted between drought periods and their rehabilitation in times of need would be too slow for effectiveness and too costly for justification. In this area there are innumerable opportunities for small reservoir and pumping developments, in the main adequate for stock watering and garden irrigation, but in times of need capable of saving small acreages of high-valued crops. Migration from this region is not believed extensive and the major benefit of such developments is the improvement of morale.

Of some 2,000,000 farms involved, probably not more than a half would benefit sufficiently by irrigation to justify its adoption. Not more than one-fourth would care to make the effort even with material assistance. With such assistance limited to cement, steel, or pumping equipment and the landowner performing all labor, the cost is estimated at an average of $1,000 per farm, or a total of $500,000,000. Such a program would require years of education. The farm population directly benefited would total about 3,000,000; indirectly the benefits would touch fully 10,000,000 persons on the farms and their nearby business centers. Stabilization, rather than an increase in population, is anticipated from irrigation activities in this area. The Bureau of Reclamation is not active in this area except in a few minor instances.

Great Plains region.—Bordered on the east by the subhumid area and on the west by the arid lands bordering the intermountain area, the Great Plains region, 200 to 300 miles in width, reaches from the Canadian border through the Texas Panhandle. Average rainfall varies from 15 to 25 inches per year, but often falls off a fourth or more for years on end. The easterly border has normally a mixed agriculture, turning more strongly to wheat in the drier years. Centrally of the area, wheat is king wherever lands are suitable for bonanza farming; a year of drought brings economic coma; protracted drought, wholesale migration. The westerly portion is frankly regarded as a plain agricultural gamble, sparsely settled and booming only with providential rainfall coming all too seldom. Average farm holdings increase from about 160 acres at the eastern border to fully 500 acres at the west.

Irrigation in this region, while important in some localities, is negligible for the area as a whole. The objective of irrigation here is to provide farming opportunities for potential migrants, and to assist in stabilizing adjacent towns, dry-farmed areas, and range lands. Much of the dry-farmed area should be depopulated and restored to range.

Although several streams crossing the Great Plains have their origin in mountain snows, notably the Missouri, Platte, and Arkansas Rivers, only the Missouri and Yellowstone Rivers carry large flows of mountain waters into, and through, the area. The others, like the local streams, are dependent on erratic rains, except where sandy soils maintain steady base flows, already largely utilized.

Utilization of Missouri and Yellowstone River waters involves pumping with moderate acre costs for construction but formidable annual costs for power. While numerous small projects exist, there are also large projects costing up to $100,000,000 without opportunity for favorable partial developments.

All other streams require costly storage regulation. Droughts fostering irrigation also impair stream flows, while lack of cheap reservoir sites precludes holdover from years of

Who's Who on Grand Coulee Dam, Washington. ***Left to right:*** **A. F. Darland, Construction Engineer; F. A. Banks, Supervising Engineer; Bert Hall, Chief Inspector; J. H. Miner, Assistant Supervising Engineer**

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[1] Statement presented to Special Committee of House of Representatives investigating interstate migration of destitute citizens, Lincoln, Nebr. September 17, 1940.

better flow. In such developments, allowance is necessary for stream depletion being effected through thousands of small reservoirs yet to be constructed for livestock watering, recreation, and minor irrigation.

The average irrigated area per farm in this area should be around 80 acres, with a farm population of 4 persons per farm and a town population of 8 persons per farm. Stabilization should enable adjacent lands to absorb a population equal to those at present on lands to be irrigated.

A small part of the available water in this area would be used to supplement areas already irrigated. Opportunities for power development are very limited in this region. Flood control is not often warranted.

Although not truly a part of the Great Plains region, the lower Rio Grande Valley has been included in the statistics for the Great Plains region.

Intermountain region.—This region includes the eastern slopes of the Rocky Mountains and reaches westerly to within a few hundred miles of the Pacific coast. It is essentially an area of range and irrigation as dry farming is almost negligible. Livestock production heavily influences farming operations. Irrigation development will be limited by water supplies and will never exceed 5 percent of the land area. Lands to be irrigated are arid and unpeopled. Thousands of small reservoirs built for range improvement have depleted irrigation supplies. Other thousands are proposed. Care should be exercised in such construction to avoid unnecessary waste, by useless evaporation, of waters needed for irrigation.

About one-half the remaining unused water, and in places all, will be needed as a supplemental supply for irrigation systems built in times of better run-off. More money will need be expended for reservoirs than for other purposes. Opportunities for incidental power development abound and power sales will assist in effecting repayment of costs besides providing needed power for proper development, including that of mineral resources. Flood control is generally desirable and can be advantageously combined with irrigation regulation.

Parts of the irrigated area are overpopulated, particularly in Utah, and other areas are trending in that direction. Supplemental water to increase production power of the land, and to enable crop changes, will stem a migration that is already alarming in special areas. Settlement opportunities for migrants will be afforded to the extent that irrigation development outstrips the needs for local population increases.

West coast region.—Comprising Washington, western Oregon, California, and southwest Arizona, this region represents the area directly tributary to tidewater cities. With few exceptions water supplies exceed land areas that may be developed. A rapidly growing population, due more to immigration than local increase, has spurred irrigation development. No further generalizations are applicable.

The Columbia Basin project of central Washington, to cost about $400,000,000 for irrigation and power development, will irrigate 1,200,000 acres of lands of negligible present population. With crops ranging from alfalfa to small fruits, the average farm area is estimated at 50 acres, the farm population at 5 persons per farm, and the town population at 2 persons to 1 on the farm. The Roza Division of the Yakima project, also in central Washington, will bring into production 72,000 acres of similar lands. To the east of the Columbia Basin project another 400,000 acres may ultimately be developed, though at present satisfied with dry farming, and mainly wheat.

The Puget Sound-Willamette Valley, already in cultivation except for a moderate increase through further clearing, is gradually adopting irrigation to overcome lack of summer precipitation and secure increased yields and improved quality. Irrigation sentiment is weak and its development will come slowly. Irrigated areas in this valley are expected to reach 500,000 acres with an average of 40 acres and 6 persons per irrigated farm. A corresponding town population of 3 persons off the farm to each 1 on the farm is anticipated.

The Central Valley of California contains nearly 2,000,000 acres requiring supplemental water and about 7,000,000 acres still to be irrigated at a construction cost of about 1 billion dollars for works to provide flood control, irrigation, and incidental power development. The entire cost of this development, aside from proper allocations to flood control and navigation, will be repaid by revenues from the sale of water and of power. The present authorized project, with a cost of about $228,000,000, will provide needed supplemental water and enable the irrigation of about 175,000 acres of new lands, mostly in the San Joaquin Valley. The provision of supplemental water supplies will provide settlement possibilities equivalent to a new area of 200,000 acres.

The 7,000,000 acres of new lands that eventually may be irrigated are about equally divided between uncultivated lands largely in the San Joaquin Valley and thinly peopled grain lands, largely in Sacramento Valley. With irrigation, farms are expected to average 40 acres with 5 persons each, in San Joaquin Valley, and 80 acres with 6 persons each in Sacramento Valley. Town population in this valley is estimated at 4 persons per farm person.

Southern California, except in the Imperial and Coachella Valleys under the All-American Canal, offers little opportunity for added irrigation as its water supplies are so largely and intensively utilized. The Metropolitan Aqueduct importation of 1,050,000 acre-feet annually from the Colorado River will do little more than overcome deficiencies in irrigation supplies for existing areas and meet growing municipal and industrial requirements in the Los Angeles region. Some farmed areas will be more intensively farmed and subdivided but such gains will be offset by equal or greater losses in areas converted to nonagricultural uses.

The All-American Canal project of southern California and the Gila project in Arizona will ultimately place about 800,000 acres of desert, largely public land, under irrigation at a cost of about $100,000,000. More than half the ultimate area will receive service from works now under construction. The average farm area for these lands is estimated at 50 acres with 4 persons per farm in addition to the present farm population, and a town population of three times as many. Much of the area is a sandy desert soil, adapted only to specialized crops after expensive preparation.

Repayment of construction costs.—Construction by the Bureau of Reclamation falls into four categories. The Boulder Canyon project, with its All-American and Coachella Canals serving Imperial and Coachella Valleys, the Central Valley project of California, and the Columbia Basin project with its Grand Coulee Dam, comprise a group of multiple-purpose projects especially authorized for construction with general funds. Boulder Dam costs will be repaid almost wholly by power revenues, as will substantial investments in the Central Valley project and Grand Coulee Dam. Cost of the All-American and Coachella Valley Canals will be repaid under the Reclamation law; on the others, costs allocated to irrigations will be so repaid.

Provisions of Reclamation Appropriation Act of 1939

Most projects now under construction were authorized under provisions of the Reclamation law and depend on appropriations from the Reclamation fund. Prior to 1939, practically all costs were charged to irrigation, to be repaid in most cases in 40 years without interest, and power revenues assisted in repayment. The Reclamation Project Act of 1939 provides for allocation of construction cost to irrigation, power, flood control, and other purposes, with irrigators responsible only for the repayment of costs allocated to irrigation. All major projects involve multiple uses. Power revenues assist materially in meeting other costs.

A 1939 appropriation of $5,000,000 provides for construction and settlement of projects in the Great Plains region. The projects included in this program at this time include the Buffalo Rapids Units 1 and 2 in Montana, Rapid Valley project in South Dakota, the Bufford-Trenton and Bismarck projects in North Dakota, the Mirage Flats project in Nebraska, and the Eden project in Wyoming. The Saco Divide Unit of the Milk River project in Montana may be added. Construction is carried out with WPA labor and repayment requirements are limited to expenditures from the $5,000,000 appropriation, to be repaid in 40 years without interest.

The Wheeler-Case law of August 11, 1939, authorizes construction of projects with the aid of WPA, CCC, and other Federal agencies. Outside assistance may also be accepted. Repayment is required in 40 years, without interest, of funds expended from appropriations under this act, together with such other expenditures as the President may direct, not exceeding costs allocated to irrigation. An appropriation of $3,500,000 was made for the fiscal year 1941. Projects are to be limited to a maximum use of $1,000,000 of Wheeler-Case funds, per project.

In the Great Plains region project construction costs are estimated to average $125 per acre, with $75 estimated as the limit of repayment ability. Here annual costs for operation are made unusually high by power costs for the many projects requiring pumping. Flood control allocations are seldom justified and construction must therefore largely come under the Great Plains and Wheeler-Case authorizations. Some, however, are too large to come under the Wheeler-Case law and at present can only be built by special authorization under the 1939 Reclamation law.

In the Intermountain region many of the smaller projects can only be constructed under the Wheeler-Case law as irrigation interests could not repay all costs properly chargeable to irrigation, and power possibilities are unattractive. The larger projects usually justify flood control or power allocations adequate to take up construction costs not properly allocable to irrigation. Project developments, including power, are estimated to average $160 per acre, of which a large part will be repaid by irrigation and power.

The situation on the West coast is similar to that in the Intermountain region, except that little development will come under the provisions of the Wheeler-Case law, and average construction costs of $150 will be fully repaid out of income from sales of water and power.

In the 38 years of its construction activities, the Bureau of Reclamation has transformed desert areas into more than 50,000 farm homes in 15 States.

Of these irrigated farms, which represent about one-fifth of the total thus supplied with water in the United States, there are around 10,000 in the Great Plains region; 34,000 in the Intermountain area; and 8,000 in the West Coast States.

Throughout its history the Bureau of Reclamation has preceded construction of each project by an investigation of its water and land resources. Available funds have never been adequate to the task of providing inventory of western resources, but the purpose has been held in mind so that the work should lead to a comprehensive view of the possibilities and the potentialities of all areas of the West. It has long been recognized that the social and economic development of the West rests largely on economic utilization of its limited water supplies.

I should like, therefore, to review for the benefit of the committee some of the estimates we are now able to make with respect to future irrigation developments in the arid and semiarid region. There are at this time approximately 20,000,000 acres under irrigation in the 17 Western States. Our investigations have brought a conviction that unused waters can be conserved to give an assured supply to the present lands and to reclaim an additional area slightly larger than the present area. Supplemental water for areas already developed will bring a larger measure of security and increased productivity to 11,000,000 acres, or 123,000 farms, which are now or will be in the future faced with retrogression because of existing or developing water shortages.

I am referring, of course, to about what now seems to us the ultimate development. This picture, in other words, is what might be seen at some time far in the future when the projects have all been built and our waters utilized as far as practicable.

There is water and suitable land to create approximately 383,000 new farms. On these new farms to be irrigated, and in the towns which will grow up among them, nearly 6,000,000 persons will make their homes. These future developments will create property values of $16,000,000,000. In addition, the supplemental water projects yet to be constructed can provide opportunities for 679,000 persons on 45,000 additional farms and the accompanying developments.

A table has been prepared to give a clearer picture of the possibilities presented in this arid and semiarid region by the unused water and land resources.

The enactment of the Wheeler-Case law has materially broadened the field of activity for the Bureau in that it paves the way for the construction of numerous small meritorious projects which cannot be expected to repay entirely their cost of construction, as required by the older Reclamation law. The lack of repayment ability on these projects is offset through the use of WPA and CCC labor, which might otherwise be employed on less permanent work.

At the present rate of development, supplemental water would be annually extended to an average of 2,500 farm units, and the resulting reduction in size of farms would release 1,000 farm units for new settlers. New irrigation projects would bring in 7,000 new farm units per year. The farm and town population supported by these developments would average 110,000 persons per year and their wealth would increase at the rate of $300,000,000 per year.

Construction of irrigation projects is well adapted to providing constructive work in areas where it is needed, and where the alternative is largely one of direct relief. The irrigated regions are practically devoid of industrial establishments that will benefit by war defense activities. In some localities increased mining will provide some employment, but not in numbers. The program of construction of schools, municipal improvements, and highway construction fostered by various forms of Federal financial assistance in the past 7 years, has very largely filled all justifiable needs of this nature.

Irrigation construction work, particularly with the force account basis under the Wheeler-Case law, permits the utilization, to a large degree, of local labor with little or no previous construction experience. An annual expenditure of $75,000,000 per year of reimbursable funds, with allowance for the use of WPA labor, will provide 100 million man-hours of labor per year for local residents—30 hours a week for 65,000 workers. The further expenditure of about $25,000,000 annually for local supplies, services, and the employment of skilled labor will further assist in quickening business life in the communities with benefit to distressed farmers. Such monetary assistance will effectively anchor large numbers of prospective migrants until completion of irrigation works enables permanently increased agricultural activities.

Present and potential [1] irrigation development in Western United States

	Great Plains region	Intermountain region	West Coast region	Total
Present:				
Areas now irrigated	2,100,000	13,400,000	5,800,000	21,300,000
Farm homes created	20,000	135,000	120,000	275,000
Potential:				
Area to receive supplemental water (acres)	700,000	8,000,000	3,000,000	11,700,000
Farm homes to be protected	7,000	66,000	50,000	123,000
New area to be irrigated (acres)	4,500,000	6,400,000	11,100,000	22,000,000
OPPORTUNITIES FOR SETTLEMENT				
Supplemental water projects:				
Farm homes to be created	2,000	33,000	10,000	45,000
Added population:				
On farms	8,000	165,000	40,000	213,000
In towns	16,000	330,000	120,000	466,000
New land projects:				
Farm homes created	56,000	107,000	220,000	383,000
Added population:				
On farms	224,000	535,000	880,000	1,639,000
In towns	448,000	1,070,000	2,540,000	4,058,000
Total new farm homes	58,000	140,000	230,000	428,000
Total additional population	696,000	2,100,000	3,580,000	6,376,000
Property values to be created	$1,400,000,000	$4,000,000,000	$10,600,000,000	$16,000,000,000
Total ultimate irrigated area (acres)	6,600,000	19,800,000	16,000,000	43,300,000
Total utlimate farm homes	78,000	275,000	350,000	703,000

[1] Estimated.

Arizona Desert

Home on a reclamation project

An irrigated farm

Farm and Home Opportunities

[See Note at close of listings]

Yuma Project, Arizona

Description	Price and owner	Remarks
15 acres, sandy soil; no alkali; on improved road 3 miles to paved road. SW¼SW¼SW¼ and S½ NW¼SW¼SW¼, sec. 9, T. 10, R. 23.	Contact Bureau of Reclamation, Yuma, Ariz.	All in full bearing Marsh seedless grapefruit, planted in spring of 1927; average productivity.
10 acres, unit B, NW¼NE¼ SW¼, sec. 5, T. 10, R. 23, located about 12 miles from Yuma. No alkali; average productivity; well leveled.	Price and terms to be determined. T. R. White, Kingman, Ariz.	
10 acres, SE¼NE¼NE¼, sec. 6, T. 10, R. 23. Sandy soil; no alkali; on improved road; well leveled.	$250 per acre; down payment of $1,000; balance in 2 years. Contact Bureau of Reclamation, Yuma Ariz.	No crop ever raised.
40 acres, SW¼ NW¼, sec. 25, T. 8, R. 22. Soft loam; more than average productivity; no alkali; ½ mile to paved road; not leveled.	$50 per acre; one-third down; balance to suit purchaser. Contact Bureau of Reclamation, Yuma, Ariz.	
90 acres, E½SW¼ sec. 25, T. 10 S., R. 25 W., G. & S. R. M. Sandy loam; no alkali; more than average productivity; well levelled; on improved road ½ mile to paved road.	$150 per acre; $2,000 down; balance reasonable terms. Owner: S. C. Sharon, 6431 Garvanza Ave., Los Angeles, Calif.	

Rio Grande project, New Mexico-Texas

44 acres, 3 miles from Las Cruces, ¼ mile to paved road.	$6,000, half cash. Mrs. H. C. Johnson, Las Cruces, N. Mex.	Small adobe house; good soil, no alkali; 14 acres new alfalfa, 16 cotton.
108 acres, about half in cultivation, 20 miles from El Paso, Tex.; on paved road, very productive	$14,000; $2,000 down, balance long yearly terms, 6 percent. W. Y. Ellis, 401 East Franklin St., El Paso, Tex.	Large residence, 3 smaller houses, barn, 2 teams, and equipment.

Belle Fourche Project, South Dakota

Description	Price and owner	Remarks
160 acres, 6 miles west of Newell, S. Dak., on gravelled county road, NW¼ sec. 21, T. 9 N., R. 6 E., BHM; 62 acres under the ditch, 55 acres under irrigation, 7 acres will need additional drainage correction. Clay loam soil sloping to level.	$6,000; $1,000 cash and $1,700 in 5 annual payments at 5 percent, purchaser to assume Federal Land Bank Commissioner loan $3,300. Ole Tysdal, Newell, S. Dak.	8-room house in good condition, full basement, large cistern, horse barn, cow shed, sheep sheds, chicken coop, granary, garage, ice house. Farm traversed by Indian Creek. About 30 acres bottom land; about 35 acres dry land above the ditch.
80 acres, 68 acres irrigable, E½ NW¼, sec. 26, T. 9 N., R. 4 E., BHM. Clay soil, mostly level land, some rolling, traversed by Owl Creek.	$1,500; ¼ down, balance suitable terms at 5 percent. J. J. Lohr, Newell, S. Dak.	5-room 1-story stucco house, stable and sheds, including granary, chicken coop, garage, and ice house. About ¼ of irrigable land not developed. Noxious weeds will need attention.

Note.—This is a continued feature from the August issue, and, as therein stated, *the facts presented are subject to verification, as the Bureau of Reclamation cannot undertake this task, and cannot be responsible for the accuracy of representations made.* Interested persons should communicate direct in accordance with the information contained in the listings. Listings should be cleared through project offices shown on the inside of the back cover page.

New Boulder and Buffalo Rapids Maps

THE Bureau of Reclamation has issued the following maps which may be obtained upon application to the Bureau of Reclamation and enclosing check or money order drawn to the Treasurer of the United States. Postage Stamps Are Not Acceptable.

The Vicinity of Boulder Dam (showing reservoir); Map No. 40-40 (1940); colored, size 22 by 30 inches. Price 25 cents.

Buffalo Rapids Project, Montana; Map No. 40-48 (1940); colored; size 11½ by 22 inches. Price 15 cents.

Walker R. Young Appointed Assistant Chief Engineer

WALKER R. YOUNG, Supervising Engineer of the Central Valley project, California, has been promoted to the position of Assistant Chief Engineer of the Bureau of Reclamation, with headquarters in the Denver Office, as announced on October 16 by Secretary of the Interior Harold L. Ickes.

The Central Valley project, of which Mr. Young has been in supervisory charge since the fall of 1935, is being built by the Bureau of Reclamation to provide the Great Central Valley of California with a much needed supply of supplementary water for irrigation.

Born in Butler, Ind., May 7, 1885, Mr. Young was graduated from the University of Idaho with a B. S. degree in engineering in 1908. He worked as chainman, rodman, surveyor, and topographer for the Great Northern Railway and other private concerns until 1911, when he was appointed Assistant Engineer in the Bureau. As a Reclamation engineer he took part in designing the Arrowrock Dam, on the Boise project, Idaho, which, when completed in 1915, was the highest dam of its type in the world.

In 1916 he headed the mechanical and dam division of the designing department in the Chief Engineer's Office in Denver, in which division are prepared the designs and estimates for the Bureau's storage works, including dams of all types and their spillways and outlet works.

In 1921 Mr. Young was placed in charge of field investigations leading to the adoption of the plan for the development of the Colorado River. He formulated the original designs and estimates for Boulder Dam.

In 1924 he was detailed to an investigation of the salt water incursion from Sacramento Bay into the Sacramento and San Joaquin Rivers, and two years later was appointed construction engineer of the Kittitas Division of the Yakima project, Washington.

With his designation in 1931 as construction engineer in charge of the building of Boulder Dam, for the second time in his career he participated in the building of the highest dam in the world, continuing in supervisory charge during the entire construction period.

All-American Canal Celebration

OCTOBER 12 was a gala day for the Imperial Valley as water from the All-American Canal was turned into the East Highline Canal. The Board of Supervisors had passed a resolution declaring Saturday, the 12th, a special holiday and called upon business houses to close for the afternoon in order that there might be a full attendance at the ceremony.

King Neptune's arrival escorted by Imperial Valley sheriff's posse and Quechan Indians was a feature of the program. The Yuma High School band and Calexico Cavalcade Serenaders gave color to the occasion. Mark Rose, promoter of the project, who was to have addressed the gathering attended only as a silent witness because of the recent death of Mrs. Rose. His appearance on the platform was greeted by a 1-minute period of silence in deference to him. The ceremony started with the introduction of visiting dignitaries and speeches were made by Chairman Evan T. Hewes, of the Imperial Irrigation District Board of Directors; Commissioner of Reclamation John C. Page; and Phil D. Swing, former representative in Congress from California, who was instrumental in the passage of the Boulder Canyon Project Act, being co-author with Senator Johnson of the bill which was enacted into law.

Some of the highlights of the address of Commissioner Page are as follows:

As we turn the water from the new All-American Canal into the East Highline Canal, which has been serving you these many years, we mark the dawn of a new era in the Imperial Valley. It will be an era of security from drought, of complete control of the transmission of your vital irrigation water, and of a large measure of protection from floods.

The Bureau of Reclamation and the Imperial Valley had their beginnings at about the same time. The Bureau was born of the idea that the Federal Government should participate in the development by irrigation of the arid and semiarid West to create farm homes and to add to the national wealth. Your valley was born of Rockwood's dream; of the vision of an engineer who saw that he could make a garden in the most forbidding desert on the continent by irrigation with water taken from the Colorado River.

Early Discouragements

It has taken nearly 40 years and many vicissitudes to bring us together here. The pioneers among you will remember some of the tribulations: the low water of 1904, which led to the cutting of the bank of the river in order to drain the last drop to the struggling settlers in the valley; the flood of 1905, which turned the whole river through a break at that temporary heading; and the slashing, ripping floods that followed until the break was closed heroically in 1907. Even the children here know that these events led years later to the subjugation of the Colorado River by the construction of Boulder Dam and the All-American Canal.

I come here with a full heart to participate in this occasion today. It was my good fortune to be one of those assigned from the outset to the work of building Boulder Dam. To me, the sight of water flowing from the All-American Canal into your canal system signalizes the completion of the greatest work entrusted to the Bureau of Reclamation. Boulder Dam is a magnificant thing. It is the ring in the nose of the wild bull of the Colorado which makes it possible for us to lead him and make him do our will. Its generators already are furnishing about half of the power used in the Los Angeles metropolitan area, and thus they assume great importance in the economy of the whole Southwest. Boulder Dam makes possible the transmission of domestic water to the southern California coast. It controls floods and improves navigation. It has created beautiful Lake Mead where great numbers find relaxation, pleasure, and solace. But to those who work in the Bureau of Reclamation, Boulder Dam was not complete until through this canal waters flowed on to your land to irrigate your crops.

In recent years, the Reclamation revolving fund has been supplemented by funds made available from the general treasury in order that large projects might be undertaken. The Boulder Canyon Project Act, which my good friend and your good friend, Phil Swing, helped to guide through the Congress, stands as the authority for the appropriation of general funds for the construction of the All-American Canal. The All-American Canal, despite technical bookkeeping, is one of our growing family of Federal Reclamation projects.

Fundamentals of Reclamation

The fundamental purposes of the Reclamation program are to provide the opportunities for the establishment of homes and to increase the security of agriculture in this dry region. The Boulder Canyon project—Boulder Dam and the All-American Canal—serves admirably these ends.

Boulder Dam establishes a firm control of the Colorado River at a point below all but two sizable tributaries. Lake Mead is large enough to store the normal flow of the Colorado River for 2 years, and it now contains sufficient water to supply the usual irrigation demands of the Imperial Valley and all other irrigated sections downstream for more than 3 years. With this storage capacity—more than 32,000,000 acre-feet—and the reserve which already has been built up, there is little doubt that the water, upon which rests the security of the homes in the Imperial Valley, is now amply assured. East of us, the mesa eventually will be green with the irrigated crops of farmers who will make homes there. A long arm of the All-American Canal will reach north beyond Salton Sea into the Coachella Valley to extend similar security and also to help make new homes there.

A Federal Reclamation project is successful only insofar as the families who have made homes there are successful in maintaining decent levels of living. I am glad, therefore, that the All-American Canal is making it possible to put electric lights and power on the farms in the Imperial Valley. This water, now flowing into the East Highline Canal on its way to irrigate fields, has turned two turbines—one driving a great generator at Boulder Dam to run factories in Los Angeles and to smelt ore in Nevada, and the other driving a smaller unit where the All-American Canal drops off the mesa, this one to light the stores in your cities and the houses on your farms. Electrification of these farms distinctly marks a rise in the level of living of the people. The canal will also contribute to your prosperity. There should be no droughts to cut the size of your harvest; there will be less silt to add to the expense of maintaining your canals; there can be more farms to assist in repaying your common debt.

It probably is an old story to you, but I often think when I am in this fruitful valley of the proposal originally made in connection with it. It was made in the belief that the valley was utterly worthless. It was that the Colorado River should be turned into the below-sea-level Salton Sink to make a lake which would be easier than the desert to cross. The proposal was given some serious consideration in the very early days when Americans first came down the Gila Valley headed for adventure and gold in California.

The very fact that the Imperial Valley has twice escaped the fate of being inundated—once at the hands of the thoughtless and the unimaginative who felt that it would be easier to cross a lake on their way to exploit the California gold fields, and again at the hands of the uncontrolled river which turned furiously on the new communities the pioneers were making here—the fact that the valley has twice escaped seems to emphasize the contributions to the national welfare that have been made here. Now more than 60,000 people have made homes by irrigating the desert valley. From this peculiarly endowed place, all winter long vegetables move in carload lots to the farthest corner of the Nation. The wealth that has been created here runs into many hundreds of millions of dollars. The United States is much healthier and much richer because the Imperial Valley was irrigated.

There are elements of drama in the stories of nearly all of the irrigation developments in the West. I know of none, however, which so forcefully as that of the Imperial Valley illustrates the principal advances made so far in the conservation of our resources.

At one stage in our history when people were bent on exploitation, serious consideration was given to the destruction of a great resource—the Imperial Valley—in order to make a very slight and nonproductive gain—that of easing the journey from Yuma to the mountains. Fortunately the Nation soon was awakened to the fact that only by irrigation could a civilization be built in the arid and semiarid West. Once this was realized, nothing so foolish as the flooding of the Salton Sea could be permitted. This was a marker showing that the first step was being taken; that an aroused public could prevent the deliberate, wasteful destruction of resources.

After the Colorado had demonstrated its might in the floods of 1905–06, an aggressive campaign originated here for the control of the river and the conservation of its waters. Boulder Dam and the All-American Canal now conserve the waters of the greatest river in the Southwest and control the stream to make it wholly useful. This is a marker in the more recent advance to an active policy of preservation and prudent use of our national resources.

I am glad that it is in this work that the Bureau of Reclamation is engaged.

I assure you that it is a great pleasure to me and my staff and to construction engineer Leo J. Foster and his men to participate with you in marking the completion of the All-American Canal to your lands. This has been a big job among the big jobs the Bureau has been doing. I am happy that the canal is now serving you for whom it was built.

New Reports Available

THREE additional bulletins of the Boulder Canyon Project Final Reports Series are available in printed form. This series of reports is being prepared to record the history of the Boulder Canyon project, the results of technical studies and experimental investigations, and the more unusual features of design and construction of one of the greatest engineering feats of all time.

The three bulletins, Penstock Analysis and Stiffener Design, Model Tests of Arch and Cantilever Elements, and Thermal Properties of Concrete, are expected to be of great value to the engineering world.

The entire Boulder Canyon project is characterized by the extraordinary. The height and base thickness of the dam, the size of the power units, the dimensions of the fusion-welded, plate-steel pipes, the novel system of artificially cooling the concrete, the speed and coordination of construction, and other major features are without precedent. The magnitude of the undertaking introduced many new problems and intensified many usual ones, requiring investigations of an extensive and diversified character to insure structures representing the utmost in efficiency, safety, and economy of construction and operation.

Penstock Analysis and Stiffener Design is Bulletin No. 5 of Part V—Technical Investigations. Model Tests of Arch and Cantilever Elements is Bulletin No. 6 of Part V. Thermal Properties of Concrete is Bulletin No. 1 of Part VII—Cement and Concrete Investigations.

These three reports bring to nine the total number of studies now available in the series. Previous reports published are Bulletins Nos. 1, 2, 3, and 4 of Part V, entitled "Trial Load Method of Analyzing Arch Dams," "Slab Analogy Experiments," "Model Tests of Boulder Dam," and "Stress Studies for Boulder Dam"; and Bulletins Nos. 1 and 2 of Part VI—Hydraulic Investigations, entitled "Model Studies of Spillways" and "Model Studies of Penstocks and Outlet Works."

Penstock Analysis and Stiffener Design contains information about pipe shells and supports for the Boulder Dam penstocks. It is 139 pages long, has 36 illustrations and 16 tables.

Model Tests of Arch and Cantilever Elements contains a description of the cross-sectional or slab models of Boulder Dam, pertaining principally to internal stresses and deformations in the cantilever and arch sections. It has 140 pages, 36 illustrations, and 16 tables.

Thermal Properties of Concrete discusses the conductivity, specific heat, and diffusity of concrete. It has 154 pages, 55 illustrations, and 34 tables.

The bulletins may be obtained from the Bureau of Reclamation in Washington, D. C., or in Denver, Colo. The three new bulletins released are priced at $1 a copy with paper binding and $1.50 with cloth binding.

Reclamation Ruled Defense Agency

Under date of July 29, 1940, the Civil Service Commission issued an order inviting attention to Departmental Circular No. 225 setting forth in full a letter dated July 1, 1940, from Mr. William H. McReynolds, Administrative Assistant to the President, regarding the desirability of placing restrictions on shifting personnel to and from defense agencies. Mr. McReynold's letter includes the following paragraph:

"In ordinary times, it would seem to be good policy not only to permit transfers freely within the Government structure but to facilitate them. During the present period, however, the urgent needs of the Government itself may demand the retention of personnel in positions in which they can render the most valuable service to the national defense program. Consequently, shifting them to other agencies in which their services would not be as valuable might justifiably be prevented or postponed."

Under the provisions of this order certain administrative and field offices of the Bureau of Reclamation have been certified in the category of national defense units. These are as follows:

Washington, D. C.; Denver, Colo.; Boulder Canyon, Arizona-California-Nevada; Columbia Basin, Washington; and Central Valley, California.

The highly trained engineers of the Bureau of Reclamation have been greatly in demand and other agencies of the Government in the construction field have, by making promotional offers, secured their services. Among those requesting transfers was the Chief of Engineers of the Army, and by special request of President Roosevelt, Assistant Secretary of War Patterson issued instructions in October to the Chief of Engineers not to take anyone from the Bureau of Reclamation.

Heart Mountain Contract

A CONTRACT for the construction of an additional 28 miles of branch canals or laterals to serve approximately 5,600 acres in the Heart Mountain Division of the Shoshone project, Wyoming, was awarded October 8 by Secretary of the Interior Harold L. Ickes.

Ray Schweitzer of Los Angeles, Calif., submitted the low and successful bid of $166,196.90, nine proposals having been received and opened by the Bureau of Reclamation at its Cody, Wyo., office on September 6, 1940.

This contract covers earthwork and structures for three laterals, designated as Laterals H–89, H–103, and H–105, and some sublaterals. Structures include checks, weirs, drops, and siphons under the tracks of the Chicago, Burlington & Quincy Railroad. The contractor is required to complete all of the work within 425 days.

When the distribution system is completed water will be available for irrigating approximately 41,000 acres of land, of which more than 38,000 acres are public land that will be opened for settlement in accordance with provisions of the Reclamation Law.

The Shoshone Canyon conduit heads at the Shoshone Dam and tunnels down the south side of the Canyon, about 3 miles. The Heart Mountain Canal begins at the outlet of the conduit, is carried over the Shoshone River by an inverted siphon, and extends in a northeast direction about 28 miles.

About 23 miles of the Heart Mountain Canal are completed. Contracts have already been awarded for the construction of about 40 miles of laterals to serve 10,000 acres of land.

Use of Floating Pans in Lake Mead

By TOM C. MEAD, *Associate Engineer, Boulder City, Nevada*

MORE WATER is lost yearly by evaporation from Lake Mead, the reservoir impounded by Boulder Dam, than would be required to completely fill Madden Reservoir, the lake which makes possible operation of the Panama Canal, and in any set of detailed calculations on the Colorado River water supply, the evaporation from Lake Mead would have to be taken into account.

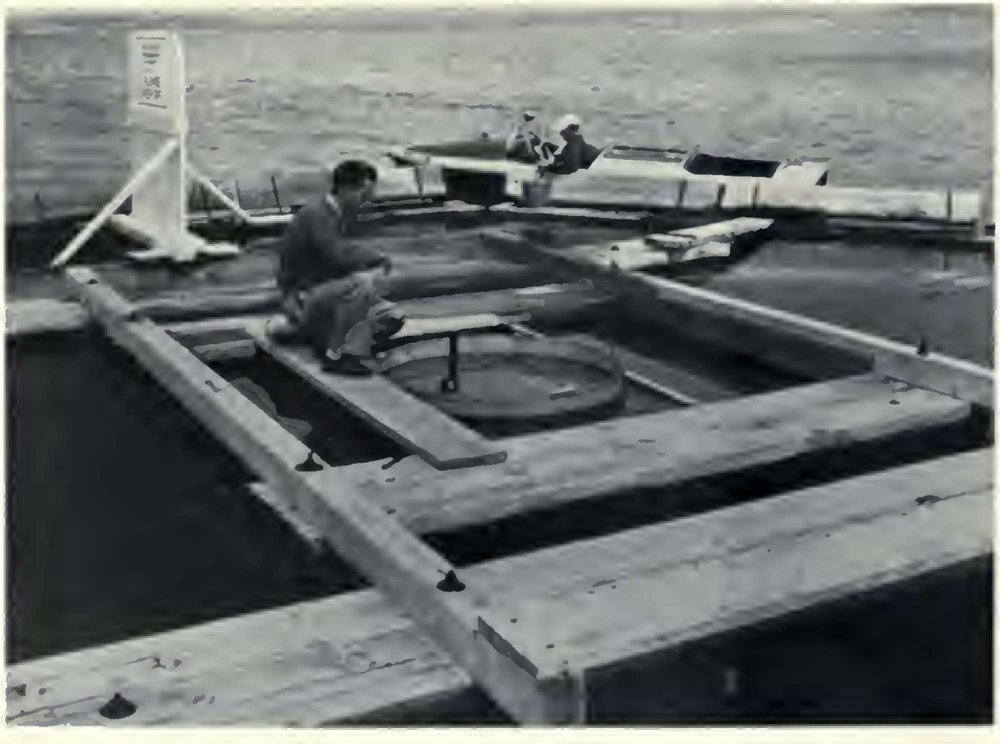
Where water is limited, the loss from evaporation must be measured to complete the inventory of net dependable water supplies. There are times when this loss can be obviated to some extent by practical measures as proposed in Utah, by diking off a portion of Utah Lake. No similar suggestion is inferred for Lake Mead, but the large amount of evaporation from this body entitles it to attention.

Bureau Conducts Research on Newly Formed Lake

In the fall of 1935, when Lake Mead began to spread out from the channel of the old Colorado River, the Bureau of Reclamation installed three evaporation pans on rafts anchored in the lake, one each on the windward and lee sides of the first large basin upstream from Boulder Dam, and one in the basin nearest Pierce Ferry some 42 miles, airline distance, upstream from the dam. The two pans nearer the dam were assumed to measure evaporation in the large exposed areas of the lake, and the pan near Pierce Ferry was assumed to measure the evaporation in more sheltered deep-canyon portions of the lake.

No. 2.—Floating evaporation pan on the south side of the Las Vegas Wash. In center within white fence is the Nevada land evaporation pan

No. 1.—Technician prepares to measure evaporation in pan



The ideal sought in using a partly submerged pan on a raft was to obtain conditions as nearly as possible identical with those on a natural lake surface. Unfortunately, natural conditions cannot help being disturbed. The pan itself and the necessary protective baffles, to shield the pan from wind and waves, hinder the free circulation of air and water, creating an artificial condition differing from that on the surrounding lake. This shielding increases evaporation from the pan. For a Class A Weather Bureau pan, such as used here, some experiments indicate that the floating pan evaporation is about 1.3 times the natural lake evaporation. That assumption is made in connection with the tests at Lake Mead.

Photograph No. 1 shows the general construction of two of the rafts. The timbers are intended to stop waves breaking into the pan. The sides of the pan project above the lake level affording additional protection. A triangular baffle inside the pan helps to prevent water slopping out.

Change in Water Level Measured Periodically

Twice a week an observer visits each pan to measure the change in water level. This he does with a portable hook gage from a stilling well support. The stilling well is a section of pipe attached to an adjustable triangular base. Hook gage and stilling well in position for observer's use are seen a foot or two ahead of the observer in photograph No. 1.

At each visit the observer replenishes evaporated water with water from the lake. Occasionally he renews it entirely to prevent gradual concentration of the dissolved solids carried in solution in lake water.

In photograph No. 1 will be seen three folded papers held to the rim of the pan by wire clamps. These papers contain powdered indelible pencil and should rain, waves, or flying spray wet them in the period between observer's visits, the dye from the indelible pencil will run, serving warning to the observer that change of level in the pan during that period is only partly due to evaporation. He puts down the doubtful record as "missing" and replaces the discolored indicator papers with new.

A substitute for a missing floating pan record is supplied as will be explained. On the shore opposite each floating pan is a precipitation gage and a Weather Bureau Class A land pan. Photographs Nos. 2 and 3 show land stations in the distance. Readings are made at the land pan exactly as they are at the floating pan except correction is made for the effect of rainfall. Each month the ratio of the evaporation of the floating pan to that from the land pan is obtained during periods of contemporaneous record. This same ratio is assumed to hold when there are gaps in the floating pan record. When wind, waves, and other disturbances have spoiled a floating pan record, the observer uses in its place the land pan evaporation for the missing period multiplied by the ratio just referred to.

At the time the pans were installed the procedure followed here might be considered a standard one. However, at the present time the Bureau is watching with keenest interest promising new methods developed and brought to the front by research workers, hoping that one or a combination of methods will be practical for adaptation to Lake Mead conditions so that eventually the evaporation loss can be measured with greater exactness.

No. 3.—Pierce Ferry floating pan with land pan on shore in the distance

Secretary Ickes Orders Additional Power Equipment for Boulder Dam

POWER equipment for Unit A–5, the eleventh large generating unit for the Boulder Dam power plant, was ordered October 9.

Two contracts were awarded, amounting to $457,648. The General Electric Co. of Schenectady, N. Y., on its bid of $411,099 will furnish three 27,500-kilovolt-ampere transformers and three 230-kilovolt, 800-ampere oil circuit breakers.

The Graybar Electric Co., Inc., of Denver, Colo., on its bid of $46,549, will furnish six disconnecting switches.

These two companies submitted the lowest bids for the respective items of 11 proposals received and opened by the Bureau of Reclamation at its Denver, Colo., office on September 5, 1940.

Unit A–5 will be installed in the Arizona wing of the U-shaped powerhouse. The transformers to be furnished under one of the contracts awarded will be installed on a platform along the river side of the Arizona wing of the powerhouse.

A contract for a 14-foot butterfly valve to be used as a shut-off valve for the turbine of Unit A–5 was awarded October 4.

The Consolidated Steel Corporation, Ltd., of Los Angeles, Calif., submitted the successful bid of $148,500, which was the lowest of three proposals received and opened by the Bureau of Reclamation at its Denver, Colo., office on September 12, 1940.

This 14-foot butterfly valve of alloy cast steel will be bolted to the flanged end of the penstock or pipe that will supply water to the 115,000-horsepower turbine. It will serve to shut off the flow of water to the turbine under emergency conditions with a maximum pressure of 300 pounds per square inch and with a flow of 8,000 cubic feet per second through the valve. Normally the valve will be operated with no flow in the penstock.

The contractor is required to ship the valve within 425 days after receipt of notice of award of contract.

Boulder City Residential Leases

RENTAL rates to go into effect at Boulder City, Nev., and the regulations governing the issuance of leases of residential sites in the model governmental city were announced by the Department of the Interior on October 14, 1940.

Monthly rental rates for lots approximately 50 by 100 available as residential building sites will range from $2.50 to $20 depending on the location.

The minimum construction values of houses to be erected range from $3,000 to $10,000, also depending on the location. The highest priced residential sites command a view of beautiful blue Lake Mead, Boulder Dam's reservoir, the largest artificial body of water in the world.

Lessees must satisfy City Manager Sims Ely that they are citizens of the United States, of good character, financially responsible, and without intention of leasing for speculation. Renewals of present leases are also within the discretion of the city manager for periods of 10 years from their date of expiration.

Rental rates are not to be increased within the life of a lease but may be lowered by the Secretary of the Interior at the end of any 5-Year period from promulgation of the regulations.

Annual Meeting

THE annual meeting of the Association of Land Grant Colleges and Universities will be held at the Drake Hotel, Chicago, November 11–13, inclusive.

CCC Accomplishments on Federal Reclamation Projects

FISCAL YEAR 1940

By ALFRED R. GOLZÉ, *Supervising Engineer, CCC*

IN THE fiscal year 1940 the 44 CCC camps allocated to the Bureau of Reclamation directed their activities to the permanent improvement of 30 Reclamation projects in 15 Western States. Work on all projects continued to go forward with little delay, except where it was disturbed by unusual conditions of weather or other circumstances beyond the control of the project authorities.

The problems of each Reclamation project differ somewhat from those of each other project; however, there is a certain similarity on the whole, particularly true of the operating projects, that is responsible for a general uniformity in the type of work carried on by the CCC camps on Reclamation projects. Water-control structures vary in design on the different projects, but their construction is well suited to the CCC enrollee whether it be on a project in Montana or one in New Mexico. Operating roads are essential everywhere to facilitate the travel of ditch riders and other officials in their duties connected with the safe delivery of irrigation water to its ultimate consumer. Protection of this water in transit is a responsibility of no small degree resting on the shoulders of the operating official. Through the work of the CCC during the past years this responsibility has become less of a burden. Weed control, rodent control, leveling of spoil banks, planting of trees for windbreaks, experiments with different types of pasture grasses, and the fighting of forest and grass fires are only a few of the other activities carried on by the CCC on reclamation projects.

Emergency work has, as in past years, continued to occupy much of the time of enrollees. Canal breaks on the Owhyee project, an earthquake on the Yuma project, and floods on the Orland project, at Tule Lake and on the Yuma project were particularly severe. Fires, both forest and grass, were numerous in the dry summer of 1939 and the early summer of 1940. Searching for persons drowned in canals or rivers or lost in the desert or mountains has become a routine responsibility of the Reclamation camps, in cooperation with the local authorities.

Improvements to Dams

Improvements to the dams of the Bureau of Reclamation were a primary work project of the CCC in the fiscal year 1940. Outstanding was the completion of the upper embankment of the Deer Flat Reservoir on the Boise project, raising Clear Lake Dam on the Klamath project, constructing the parapet wall on the Moon Lake Dam on the Moon Lake project, the Pine View Dam on the Ogden River project, and the Agency Valley Dam on the Vale project, making miscellaneous improvements at the Boca Dam on the Truckee storage project and the Taylor Park Dam on the Uncompahgre project, and cleaning up the area around Arrowrock Dam.

Work on Operating Projects

On operating projects, as in past years, principal attention was given to rehabilitation of physical features, with the objective of conserving water by means of permanent construction.

On the Belle Fourche project in South Dakota enrollees manufactured concrete pipe and used it in the construction of culverts and turn-outs. Other structures were completely rebuilt with concrete, and canals were lined with concrete where necessary. A large concrete flume on the South Canal was built by the CCC enrollees.

General improvement of the distribution system of the Boise project, Idaho, was continued. Canals and laterals of the project were riprapped, cattle guards were built on operating roads, the Mora Siphon was rebuilt, 96 concrete weirs for accurate measurement of water were installed, and a weed-control campaign was actively conducted.

In addition to the Hackberry Draw flood-control works, on the Carlsbad project, New Mexico, attention was directed to the landscaping at Avalon Dam, rock and concrete lining of canals, and the control of rodents. Work was begun at Alamogordo Dam for a recreational development, and some work was done to improve the spillway channel below the dam.

In Colorado, the Grand Valley project saw the reconstruction of minor structures and lining the main canals and laterals make excellent progress.

On the Huntley project in Montana, replacement of structures, riprapping ditches with rock and gravel, and construction of operating roads continued as a major activity; an additional headgate was placed under construction for the Huntley main canal to supplement the project water supply. Experiments were in progress with bentonite to determine its value as a sealing agent.

Construction of a road to provide access to

Enrollees burn the trees and brush cleared from Shasta Dam Reservoir site, Central Valley project, California

recreational areas at Alcova Reservoir on the Kendrick project in central Wyoming was 65 percent complete at the end of the year. Plans for full use of this area are under consideration by the National Park Service.

The raising of Clear Lake Dam with the assistance of CCC forces was completed and will materially increase the water supply of the Klamath project in southern Oregon and northern California. The lining of canals with concrete and the permanent replacement of structures will safeguard the delivery of this water. The main dike on the Tule Lake sump was reinforced with riprapping and sheet piling to protect it against the pressure of flood waters. Control of noxious weeds occupied much of the time of the enrollees on this project.

On the Lower Yellowstone and Milk River projects in Montana, the replacement of structures, the construction of operating roads, the leveling of spoil banks, the riprapping of canals and structures, and the control of weeds were the principal activities.

Park development at Lake Walcott on the Minidoka project, Idaho, was continued and extended. The rock paving and riprapping of the project drainage and distribution system was the major activity. Other activities included the gravel and clay lining of canals, construction of minor structures and operating roads, weed and rodent control, and aid to the Fish and Wildlife Service in development of the wildlife refuge at Lake Walcott.

In Nevada the CCC camps continued their work in rehabilitating the Newlands project through the construction of structures, leveling of spoil banks, and weed and rodent control, and began construction of the Scheckler Reservoir, designed to conserve the winter flow of water from the Lahonton Reservoir.

A great variety of work occupied the four camps on the North Platte project in Nebraska and Wyoming. Recreational work was continued at Guernsey Reservoir and Lake Minatare. Work in the irrigated area included the construction of telephone lines, cattle guards, operating roads, lining of canals with concrete, rock and gravel, construction of water control and measuring devices, manufacture of concrete pipe, the planting of 150,000 trees, the operation of three nurseries, and weed and rodent control.

CCC forces on the Orland project, California, were mainly concerned with the rebuilding of earth laterals, lining them with concrete, the construction of operating roads, and miscellaneous small structures.

On the Owhyee project in Oregon the CCC have been a valuable aid in assisting new settlers by the reconstruction of the antiquated distribution systems brought within the Owhyee project. Emergency work and construction of operating roads were other primary activities of the CCC men on the project.

Down in southern New Mexico the Rio Grande project extends more than 100 miles along the Rio Grande. Throughout this area CCC forces have worked to improve the Government's system of irrigation works. Operating roads were built along the canals, water control structures were replaced, spoil banks were leveled, and ditches were fenced for pasture. The Texas lateral was extended and the banks of the Franklin Canal in El Paso were reconditioned prior to being fenced. The foundations of the Mesilla Dam were reconstructed.

CCC constructed scenic highway skirts Alcova Reservoir on the Kendrick project, Wyoming

At Elephant Butte Reservoir a fish hatchery was completed and landscaping was begun. Overnight cabins, sewer and water lines, riprapping of reservoir banks, construction of shore roads and the planting of trees and shrubs were continued in the recreational area.

The Shoshone project in northern Wyoming benefited by the construction of operating roads, rebuilding of minor structures and reconstruction of several major structures, including the Alkali Creek incline drop. Experiments in weed control and pasture grasses were continued.

On the Sun River project in Montana operating roads were constructed with CCC forces, canals were blanketed and riprapped. Spoil banks were leveled and work was continued on the Willow Creek Feeder Canal, expected to be completed early in the fiscal year 1941.

On the Uncompahgre project in Colorado replacement of deteriorated structures took precedence as the most essential part of the CCC program. The riprapping of canals and laterals and the banks of the Uncompahgre River continued the project plan for full erosion control of all waterways. Other work included the construction of operating roads, the building of drain ditches, and weed control, the latter a vitally important matter on this particular project.

CCC forces continue their work on the drainage system of the Vale project in Oregon and the improvement of the laterals and structures, the construction of operating roads, cattle guards and the control of rodents and noxious weeds. A detail from the Vale camp constructed the parapet and curb wall on the Agency Valley Dam.

CCC work was well distributed over the extensive Yakima project in Washington. Beginning with the storage reservoirs in the mountains, CCC forces continued the clearing of water-killed timber from Lake Kachess and Lake Keechelus. Concrete pipes varying in sizes from 30 to 42 inches were installed in many places on the distribution system of the project; 46- and 56-inch wood stave pipe siphons were reconstructed at several locations. Operating roads were built, spoil banks leveled, canal banks strengthened, and siphons built to replace flumes. Canals were riprapped and lined with concrete, gravel, or asphalt. Weed control was not neglected.

In the sunny climate of southern Arizona and California, CCC enrollees on the Yuma project worked throughout the year, irrespective of local temperatures. Accomplishments included the placing of drain tile, the construction of operating roads, pouring considerable concrete lining, and the building of canal structures. Precast concrete panels were installed as a lining in the lateral system, and spoil banks were leveled. The CCC men were called for emergency work following a flood

Part of the equipment operated by CCC enrollees on the Deschutes project, Oregon

in November 1939 and an earthquake in May 1940. Weed and rodent control were allied activities through the year.

Work on Construction Projects

On the construction projects the greatest amount of work with CCC enrollees was done on the Deschutes project, where at the end of the year 18 miles of the 65-mile main canal had been nearly completed and 3 additional miles stripped of earth was ready for drilling. During the summer period enrollees continued the construction of the Wickiup Dam and Dike and clearing of the Wickiup Reservoir area.

Enrollees continued with the clearing of the reservoir area at Shasta Dam on the Central Valley project. Mechanized in part, this work has none the less been outstanding, and a testimonial to the amount of work that can be accomplished by previously untrained men under adequate supervision.

On the Moon Lake project, Utah, the Midview Feeder Canal diversion dam and headgate structure on the Duchesne River was completed and placed in service. Schedule 1 of the Yellowstone Feeder Canal (10 miles) was also completed and schedule 2 (7 miles) nearly completed.

North of Salt Lake City on the Ogden River project some improvements were made to the Ogden-Brigham Canal, and the South Ogden Canal extension and wasteway which were 75 percent complete at the end of the year.

The clearing of the Deer Creek Reservoir on the Provo River project, Utah, of trees and buildings continued. Fencing of the reservoir right-of-way made good progress. A large bridge over the Provo River on the Charleston-Midway Highway was completed.

The volume of the work that the CCC boys are doing on Reclamation projects is illustrated well by the following table of a few of the more common types of work completed in the fiscal year 1940: 30,000 rods of fences; 56 miles of telephone line; 224 cattle guards; 373 signs; 983 rods of walls; 400 miles of operating roads; 45,000 linear feet of pipe lines; and 2,358 water-control structures.

In addition, enrollees in 1940 cleared 2,500,000 yards of channels and 2,200 acres in irrigation reservoirs. They lined 380,000 square yards of canals and laterals and excavated 3,380,000 cubic yards of earth and 172,000 cubic yards of rock for ditches. They placed 465,000 square yards of rock and concrete riprap, they moved 472,000 cubic yards of earth in leveling spoil banks, planted 162,000 trees, conducted weed control on 13,000 acres and rodent control on 200,000 acres; 11,000 man-days were spent battling forest and grass fires and another 11,000 man-days for miscellaneous emergency work, including floods and earthquakes.

Training of Enrollees

The young men who enroll in the Civilian Conservation Corps are generally untrained in the types of work that the camps are doing on Reclamation projects. To enable the enrollee to do good work while in the CCC and to provide him with the experience with which to secure gainful employment when leaving the CCC, is the twofold purpose of the training program established in each camp. Through the past year large numbers of enrollees received training under this program in many fields of activity associated with the conservation work of the Bureau of Reclamation.

Credit must be given to the CCC engineers, camp superintendents, foremen, mechanics, and other employees who are charged with the responsibility of conducting the job training programs in the camps. It is because of their efforts that the past year has seen the training work greatly strengthened in all the camps.

Method of Training

During the day on the job the foreman explains to the enrollees in his charge the proper way to do their work. One or two evenings a week he holds a class in camp to teach the boys of his crew the reasons for doing the work the proper way, and some of the fundamentals that underlie these reasons. Classes are scheduled in all subjects relating to the field work. In the classroom work the assistance of regular Bureau employees has been helpful in teaching qualified enrollees technical subjects and subjects of a clerical nature, such as property accountability and cost-keeping.

All job training work is outlined to insure presentation of the material in an orderly and logical manner and to coordinate the training on the job with the classroom work off the job. Each foreman-instructor prepares his own outline, usually on the basis of covering the subject in 6 months, the length of one enrollment period. For men who reenroll for a second, third, and fourth 6-month period, advanced courses are given in the subjects related to the field work for which they show a special aptitude.

Concrete and timber construction are perhaps the most common subjects in the Reclamation camps with the exception of equipment operation. Particular stress has been given to the training of operators who manage the large fleet of motorized equipment in the custody of the camps on Reclamation projects. The hundreds of trucks and tractors are operated by enrollees who thereby acquire a vocation, not only of value to themselves in securing a job on leaving the CCC, but likely to be helpful to the Nation in solving the problems arising from troubled world conditions.

The success of the CCC camps on Reclamation projects has been due in no small measure to the success of the training program. It is anticipated that as the supervisory personnel and others in charge of the training work become more familiar with the problems involved it will reach an even higher degree of efficiency. Expansion of the work of the Bureau in new areas will provide greater opportunities for employment of enrollees in work of mutual benefit to them and their Government. There is every reason to believe that the accomplishments of the camps in future years will continue to surpass each previous year's outstanding record.

NOTES FOR CONTRACTORS

Specification No.	Project	Bids opened	Work or material	Low bidder		Bid	Terms	Award of contract approved
				Name	Address			
928	Boulder Canyon, Ariz.-Nev.	Sept. 5	Power transformers, high-voltage switching equipment and lightning arrester for unit A-5, Boulder power plant.	General Electric Co do Westinghouse Electric & Manufacturing Co. Graybar Electric Co., Inc	Schenectady, N. Y do Denver, Colo do	[1] $248,694.00 [2] 162,405.00 [3] 9,285.00 [4] 46,549.00	F. o. b. Boulder City, Nev do do do	Oct. 2 Do. (5) Oct. 2
929	Central Valley, Calif	Sept. 6	Two 250-ton traveling cranes for the Shasta power plant.					
930	Boulder Canyon, Ariz.-Nev.	Sept. 12	One 168-inch butterfly valve for Boulder power plant.	Consolidated Steel Corporation, Ltd.	Los Angeles, Calif	148,500.00		Oct. 1
931	Columbia Basin, Wash	Sept. 10	Generator voltage bus structures and oil circuit breaker for Grand Coulee power plant.	I. T. E. Circuit Breaker Co General Electric Co	Philadelphia, Pa Denver, Colo	[1] 164,300.00 [2] 21,000.00	F. o. b. Odair, Wash do	Sept. 30 Do.
932	Shoshone-Heart Mountain, Wyo.	Sept. 6	Earthwork and structures on laterals H-89, H-103, and H-105 and sublaterals.	Ray Schweitzer	Los Angeles, Calif	166,196.90		Oct. 2
34,018-A	Mirage Flats, Nebr	Aug. 27	Automobile stakebody and dumpbody trucks.	General Motors Corporation (Chevrolet Division). Yellow Truck and Coach Manufacturing Co. Diamond T Motor Car Co	Detroit, Mich Pontiac, Mich Washington, D. C	[6] 3,027.87 [7] 1,679.40 [8] 19,632.00	 F. o. b. Chicago, Ill.; discount $40.	Sept. 18 Do. Sept. 26
1407-D	Columbia Basin, Wash	Sept. 5	Pipe, fittings, valves, and cocks for Grand Coulee power plant.	U. S. Pipe Bending Co	San Francisco, Calif	[9] 11,000.00	Item 1, f. o. b. Odair, Wash.; Item 2, F. o. b., San Francisco.	Oct. 1
1422-D	Colorado River, Tex	Sept. 17	48 upper tracks for bulkhead-gate frames for Marshall Ford Dam.	Valley Iron Works	Yakima, Wash	17,500.00	Discount ½ percent	Sept. 25
1423-D	Gila, Ariz	Sept. 18	Absorptive form lining for pumping plant No. 1.	Wood Conversion Co	St. Paul, Minn	1,265.00	Discount 2 percent	(5)
1417-D	Buffalo Rapids (Second Division), Mont.	Sept. 5	2 motor-driven pumping units	Fairbanks Morse Co	Kansas City, Mo	12,426.00		Oct. 2
1388-D	Shoshone-Heart Mountain, Wyo.	Aug. 7	Furnishing and installing an electric elevator for the Shoshone Canyon Conduit controlling works.	O'Keefe Elevator Co	Omaha, Nebr	[7] 15,150.00		Oct. 1
1425-D	Kendrick, Wyo	Sept. 27	Preparation of concrete aggregates.	M. J. Gilpatrick	Riverton, Wyo	3,810.00		Oct. 5
1424-D	Colorado River, Tex	Sept. 25	288 trashracks for outlet works at Marshall Ford Dam.	Stupp Bros. Bridge & Iron Co.	St. Louis, Mo	50,388.00	Discount ½ percent	Oct. 10
1429-D	Boulder Canyon, Ariz.-Nev.	Sept. 30	Structural steel for supporting structures for the Southern California Edison Co. transformer circuit and switching station.	International Derrick & Equipment Co. of California.	Torrance, Calif	4,139.00	do	Oct. 8
1426-D	Colorado River, Tex	do	Structural-steel, gate-handling frame.	Paxton & Vierling Iron Works	Omaha, Nebr	1,575.00	do	Oct. 10
1428-D	Yakima-Roza, Wash	Oct. 2	Earthwork, pipe lines and structures, Terrace Heights pump lateral, Yakima Ridge Canal.	Fyfe & Co	Nyssa, Oreg	[1] 7,916.35		Do.
1434-D	Columbia Basin, Wash	do	Structural steel, rotor-erection platform, rotor-erection girders and base, and stator-erection platform for Grand Coulee power plant.	American Bridge Co	Denver, Colo	11,992.00	F. o. b. Gary, Ind	Oct. 14
1433-D	Boulder Canyon, Ariz.-Nev.	Oct 4	Coupling capacitors, distribution transformers with protective devices and accessories. and carrier line traps for Boulder power plant.	General Electric Co do	Schenectady, N. Y do	[6] 8,267.00 [7] 2,210.00	F. o. b. Boulder City do	Oct. 17 Do.
1436-D	Central Valley, Calif	Oct. 3	15 bulkhead-gate frames and guides for main-unit turbine draft tubes; 2 bulkhead-gate frames and guides for station service unit draft tubes: 34 gate latches for bulkhead gates at Shasta power plant.	John W. Beam The Paulson Machine Works	Denver, Colo Portland, Oreg	[6] 9,000.00 [7] 1,775.00	F. o. b. Chicago, Ill 	Oct. 11 Do.
1440-D	Colorado River, Tex	Oct. 4	16-ton hand-operated trolley with one equalizer beam and trolley stops for gate-handling frame.	Cyclops Iron Works	San Francisco, Calif	2,750.00	Discount ¼ percent	Do.
1441-D	Boulder Canyon, Ariz.-Nev.	do	2 flowmeters for measuring the flow of water through the 115,000-horsepower hydraulic turbines at Boulder power plant.	Simplex Valve & Meter Co	Philadelphia, Pa	2,310.00	Discount 1 percent	Do.
925	Columbia Basin, Wash	Aug. 12	Residences at Leavenworth, Entiat and Winthrop stations for migratory fish control.	West Coast Construction Co	Seattle, Wash	[10] 29,381.00		(5)
1431-D	Central Valley, Calif	Oct. 2	2 oil purifiers and 1 filter-paper drying oven for the Shasta power plant.	The DeLaval Separator Co	Chicago, Ill	[9] 9,675.00		Oct. 14
1438-D	All-American Canal, Ariz.-Calif.	Oct. 4	Radial gates and radial-gate hoists for Coachella Canal.	Worden Allen Co Western Foundry Co	Milwaukee, Wis Portland, Oreg	[6] 2,330.00 [7] 3,366.00		Oct. 15 Oct. 17
1437-D	Parker Dam Power, Ariz.-Calif.	do	Gate frames and gate latches for 22- by 35-foot fixed-wheel penstock gates for intake structure at Parker power plant.	Valley Iron Works	Denver, Colo	41,990.00	Discount ½ percent	Oct. 21
34018-B	Mirage Flats, Nebr	Sept. 23	One 1½-cubic yard dragline excavator and two dragline buckets.	Harnischfeger Corporation	Milwaukee, Wis	[6] 35,300.00	Discount 2 percent	Do.
28337-A	Buffalo Rapids (First Division) Mont.	Oct. 1	4 Diesel-engine-powered crawler tractors.	Caterpillar Tractor Co	Peoria, Ill	22,805.00	Discount $50 each unit.	Do.

[1] Schedule 1. [2] Schedule 2. [3] Schedule 3. [4] Schedule 4. [5] All bids rejected. [6] Item 1. [7] Item 2. [8] Item 3. [9] Items 1 and 2. [10] Schedule 5.

Bonneville to Market Grand Coulee Power

THE Bonneville Power Administration was recently set up by an Executive order as the marketing agency for the world's largest supply of hydroelectric power, generated at Grand Coulee (Washington) and Bonneville (Oregon) Dams, both on the Columbia River.

The Executive order aims at an integration and coordination of the electrical facilities of the two projects. It paves the way for the expeditious marketing of vast blocks of electric power for the development of defense industries in the Pacific Northwest.

Under the terms of the order signed by the President August 26, 1940, the Bonneville Administrator is authorized to construct, operate, and maintain the transmission lines and other facilities necessary for marketing the power delivered from Grand Coulee Dam.

The power delivered from Grand Coulee for distribution and sale for which the Bonneville Administrator will act as agent will consist of the energy not required for operating the project including its irrigation features.

The Grand Coulee Dam project is under construction by the Bureau of Reclamation, Department of the Interior. Its completion will make water available for the irrigation of 1,200,000 acres of dry but fertile Columbia Basin land. It is the largest hydroelectric development in the world with a capacity of 1,944,000 kilowatts. Three generating units of 108,000 kilowatts each are now being installed and the first is expected to go into operation in October 1941.

The Bonneville project was constructed under the Public Works Administration program and has been operating for some months. It has a capacity of 518,000 kilowatts and is marketing power to Pacific Northwest municipalities, public utility districts and private industry.

Transmission Line Connects Projects

The Grand Coulee and Bonneville projects have been interconnected with a high power transmission line. The completion of transmission and generating facilities in the two projects will make large blocks of power available for defense industries. Coulee-Bonneville ultimate power capacity will approach 2,500,000 kilowatts, a capacity far beyond any other source known.

The President's Executive order reads as follows:

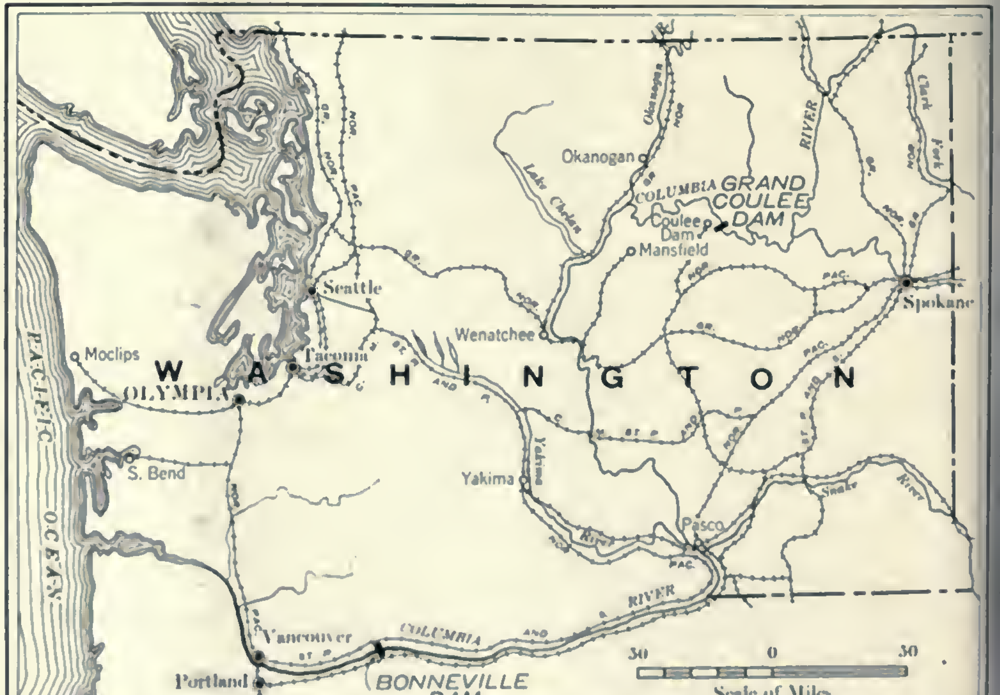
"1. The Bonneville Power Administrator is hereby designated, under the supervision and direction of the Secretary of the Interior, as agent for the sale and distribution of electrical power and energy generated at the Grand Coulee Dam project and not required for operation of that project, including its irrigation features.

"2. The Administrator shall construct, operate, and maintain the transmission lines and substations and appurtenant structures and facilities necessary for marketing the power and energy delivered to him from the Grand Coulee Dam project; except that the Bureau of Reclamation may construct, operate, or maintain such transmission facilities as the Secretary of the Interior, in his discretion, deems necessary or desirable. The Bureau of Reclamation and the Administrator, with the approval of the Secretary, shall agree upon and schedule the installation of additional generators at the Grand Coulee Dam project.

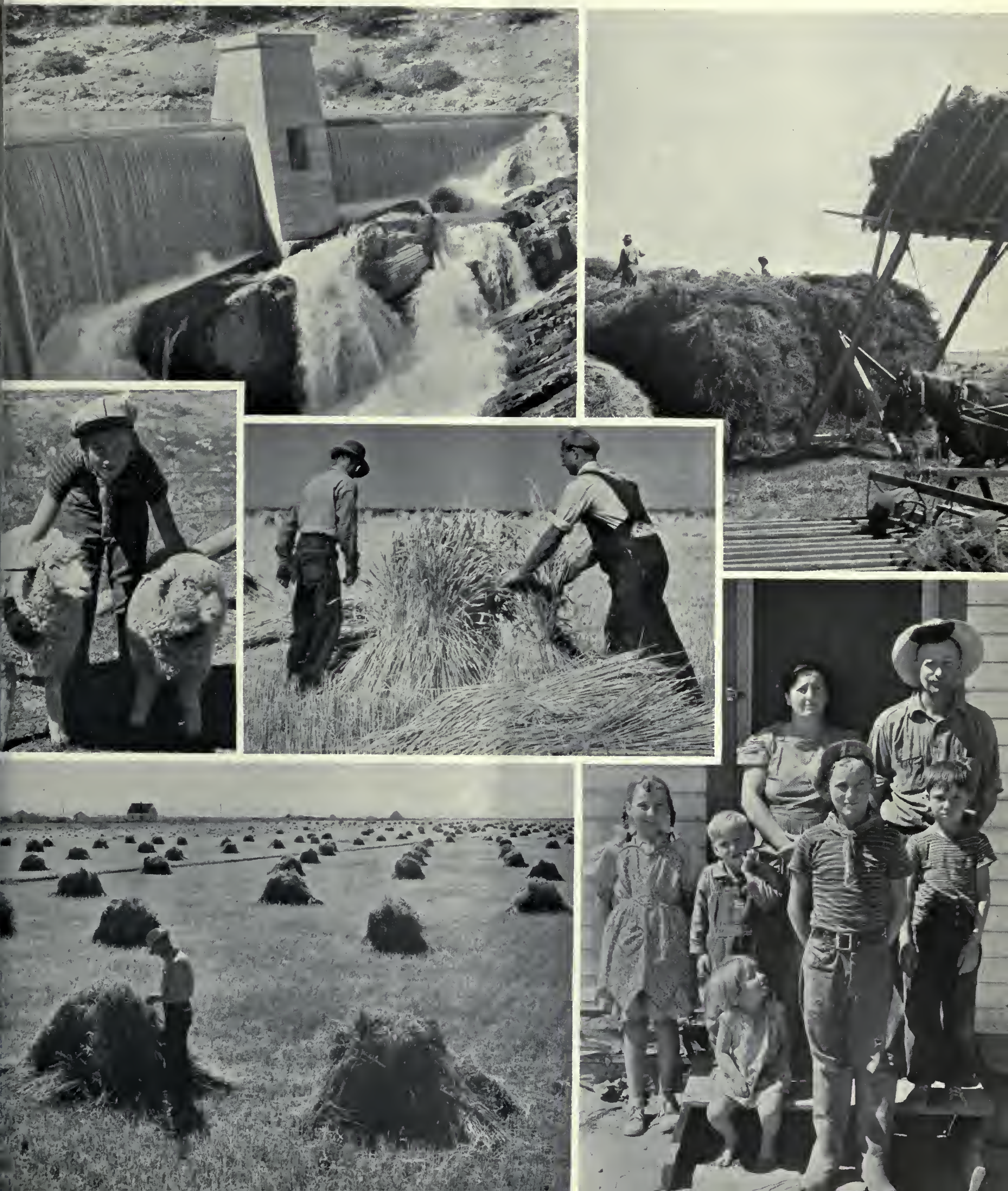
"3. The Bureau of Reclamation, with the approval of the Secretary, shall provide the Administrator with a basic schedule of the power, and energy to be available to him from the Grand Coulee Dam project. The Bureau, with the Secretary's approval, may revise the schedule from time to time, except that no revision decreasing the amount of power and energy available under an existing schedule shall be effective unless agreed to by the Administrator. The Bureau will make power and energy from the Grand Coulee Dam project available to the Administrator in accordance with these schedules.

"4. The Administrator shall market the power and energy delivered to him from the Grand Coulee Dam project at rates to be fixed by the Secretary of the Interior consistently with all applicable provisions of law and allocations of cost determined as provided thereunder. From time to time the Secretary of the Interior, consistently with all applicable provisions of law and allocations of cost made pursuant thereto shall determine the basis on which the Administrator and the Bureau shall compute the returns to be made to the Bureau for power and energy delivered to the Administrator from the Grand Coulee Dam project pursuant to this order. All receipts collected by the Administrator from transmission and sale of power and energy shall be deposited with the Treasurer of the United States for credit to a special account, subject to allocation by the Secretary of the Interior in accordance with the computations above provided for. Upon certification by the Secretary of the Interior, the amounts of receipts properly allocable to the Bonneville project shall be covered into the Treasury of the United States to the credit of miscellaneous receipts subject to the provisions of section 2 of the act of August 20, 1937, 50 Stat. 731, 732. The amounts certified by the Secretary of the Interior as being allocable to the Grand Coulee Dam project shall be covered into the Treasury for credit to the Reclamation Fund to the extent authorized by law.

"5. In aid of this delegation of authority to the Secretary of the Interior, the Commissioner of the Bureau of Reclamation and the Bonneville Power Administrator shall, subject to the approval of the Secretary of the Interior and the terms of this order, enter into any and all agreements that are necessary for the interconnection of the Bonneville project and the Grand Coulee Dam project and to carry out the provisions of this order."



IRRIGATED HARVESTS



Alien Registration Dead-Line December 26, 1940

WITH the Alien Registration program reaching its peak, Director Earl G. Harrison of the Alien Registration Division is urging that citizens cooperate with noncitizens in helping them to comply with the Alien Registration Act. Passed by Congress as a national defense measure, the Alien Registration program went into effect August 27, and will continue through December 26, 1940.

Director Harrison's request for cooperation is partly directed to employers who have noncitizens in their employ. He points out that their sympathy and advice can do a great deal to dispel any fears the alien may have about registration, particularly with respect to the security of their employment. Many of them realize that their forefathers were, at one time or another, aliens in this Nation, and they know that the great majority of noncitizens are as true to the letter and spirit of American laws as are patriotic American citizens.

Inasmuch as an alien is subject to $1,000 fine or 6 months imprisonment if he does not register by December 26, employers have a direct interest in helping their noncitizen workers comply with the law. According to a recent statement to employers from the Alien Registration Division, this interest is purely voluntary and involves "no compulsion."

EDWARD JOSEPH HARDING

1889–1940

EDWARD JOSEPH HARDING, managing director of the Associated General Contractors of America, died suddenly at Plainfield, N. J., on October 5 while en route with his wife to New York City to take a boat for a short vacation cruise to the West Indies.

In addition to his official position with the Associated General Contractors, Mr. Harding was a member of the Construction Advisory Committee to the Army and Navy Munitions Board assisting in the defense construction program, and of the Federal Advisory Council for Employment Security. His connection with the Associated General Contractors for 21 years required extensive travel and his acquaintance with contractors and their problems was unequaled.

His first contact with the construction industry was in 1906 in connection with the condemnation of land for the Hudson Tunnels. He worked on the tunnels and the Hudson Terminal Building in New York City. From 1917 to 1921 he was manager for the James Stewart Co., general contractors, of New York City.

Mr. Harding was born in Plainfield, N. J., June 13, 1889, and was married in 1913 to Miss Marie Ruth McCarty of Plainfield. He is survived by his wife, a son, Edward J. Harding, Jr., an ensign in the Supply Corps of the United States Navy now on sea duty with the U. S. S. *Colorado* in Hawaiian waters, and a daughter, Miss Ruth Anais Harding.

H. E. Foreman, assistant managing director of the Associated General Contractors, has been named to succeed Mr. Harding as managing director, and J. D. Marshall, manager of the heavy construction and railroad division, has been appointed to succeed Mr. Foreman as assistant managing director.

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CUT ALONG THIS LINE

(Date) . . . .

COMMISSIONER,
Bureau of Reclamation,
Washington, D. C.

SIR: I am enclosing my check [1] (or money order) for $1.00 to pay for a year's subscription to THE RECLAMATION ERA.

Very truly yours,

November 1940.

(Name) . . . .

(Address) . . . .

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NOTE.—36 cents postal charges should be added for foreign subscriptions.

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ADMINISTRATIVE ORGANIZATION OF THE BUREAU OF RECLAMATION

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Projects under construction or operated in whole or in part by the Bureau of Reclamation

Project	Office	Official in charge		Chief clerk	District counsel	
		Name	Title		Name	Address
All-American Canal	Yuma, Ariz	Leo J. Foster	Construction engineer	J. C. Thrailkill	R. J. Coffey	Los Angeles, Calif.
Altus	Altus, Okla	Russell S. Lieurance	Construction engineer	Edgar A. Peek	H. J. S. Devries	El Paso, Tex.
Belle Fourche	Newell, S. Dak	F. C. Youngblutt	Superintendent		W. J. Burke	Billings, Mont.
Boise	Boise, Idaho	R. J. Newell	Construction engineer	Robert B. Smith	B. E. Stoutemyer	Portland, Oreg.
Boulder Canyon [1]	Boulder City, Nev	Irving C. Harris	Director of power	Gail H. Baird	R. J. Coffey	Los Angeles, Calif.
Buffalo Rapids	Glendive, Mont	Paul A. Jones	Construction engineer	Edwin M. Bean	W J. Burke	Billings, Mont.
Buford-Trenton	Williston, N. Dak	Parley R. Neeley	Resident engineer	Robert L. Newman	W. J. Burke	Billings, Mont.
Carlsbad	Carlsbad, N. Mex	L. E. Foster	Superintendent	E. W. Shepard	H. J. S. Devries	El Paso, Tex.
Central Valley	Sacramento, Calif	R. S. Calland	Supervising engineer [2]	E. R. Mills	R. J. Coffey	Los Angeles, Calif.
Shasta Dam	Redding, Calif	Ralph Lowry	Construction engineer		R. J. Coffey	Los Angeles, Calif.
Friant division	Friant, Calif	R. B. Williams	Construction engineer		R. J. Coffey	Los Angeles, Calif.
Delta division	Antioch, Calif	Oscar C. Boden	Construction engineer		R. J. Coffey	Los Angeles, Calif.
Colorado-Big Thompson	Estes Park, Colo	Porter J. Preston	Supervising engineer	C. M. Voyen	J. R. Alexander	Salt Lake City, Utah.
Colorado River	Austin, Tex	Ernest A. Moritz	Construction engineer	William F. Sha	H. J. S. Devries	El Paso, Tex.
Columbia Basin	Coulee Dam, Wash	F. A. Banks	Supervising engineer	C. B. Funk	B. E. Stoutemyer	Portland, Oreg.
Deschutes	Bend, Oreg	D. S. Stuver	Construction engineer	Noble O. Anderson	B. E. Stoutemyer	Portland, Oreg.
Gila	Yuma, Ariz	Leo J. Foster	Construction engineer	J. C. Thrailkill	R. J. Coffey	Los Angeles, Calif.
Grand Valley	Grand Junction, Colo	W. J. Chiesman	Superintendent	Emil T. Ficenec	J. R. Alexander	Salt Lake City, Utah.
Humboldt	Reno, Nev	Floyd M. Spencer	Construction engineer [2]		J. R. Alexander	Salt Lake City, Utah.
Kendrick	Casper, Wyo	Irvin J. Matthews	Construction engineer [2]	George W. Lyle	W. J. Burke	Billings, Mont.
Klamath	Klamath Falls, Oreg	B. E. Hayden	Superintendent	W. I. Tingley	B. E. Stoutemyer	Portland, Oreg.
Milk River	Malta, Mont	Harold W. Genger	Superintendent	E. E. Chabot	W. J. Burke	Billings, Mont.
Minidoka	Burley, Idaho	Stanley R. Marean	Superintendent	G. C. Patterson	B. E. Stoutemyer	Portland, Oreg.
Minidoka Power Plant	Rupert, Idaho	S. A. McWilliams	Resident engineer		B. E. Stoutemyer	Portland, Oreg.
Mirage Flats	Hemingford, Nebr	Denton J. Paul	Construction engineer		W. J. Burke	Billings, Mont.
Moon Lake	Provo, Utah	E. O. Larson	Construction engineer	Francis J. Farrell	J. R. Alexander	Salt Lake City, Utah.
North Platte	Guernsey, Wyo	C. F. Gleason	Superintendent of power	A. T, Stimpfig	W. J. Burke	Billings, Mont.
Ogden River	Provo, Utah	E. O. Larson	Construction engineer	Francis J. Farrell	J. R. Alexander	Salt Lake City, Utah.
Orland	Orland, Calif	D. L. Carmody	Superintendent	W. D. Funk	R. J. Coffey	Los Angeles, Calif.
Owyhee	Boise, Idaho	R. J. Newell	Construction engineer	Robert B. Smith	B. E. Stoutemyer	Portland, Oreg.
Parker Dam Power	Parker Dam, Calif	E. C. Koppen	Construction engineer	George B. Snow	R. J. Coffey	Los Angeles, Calif.
Pine River	Vallecito, Colo	Charles A. Burns	Construction engineer	Frank E. Gawn	J. R. Alexander	Salt Lake City, Utah.
Provo River	Provo, Utah	E. O. Larson	Construction engineer	Francis J. Farrell	J. R. Alexander	Salt Lake City, Utah.
Rapid Valley	Rapid City, S. Dak	Horace V. Hubbell	Construction engineer	Jos. P. Siebeneicher	W. J. Burke	Billings, Mont.
Rio Grande	El Paso, Tex	L. R. Fiock	Superintendent	H. H. Berryhill	H. J. S. Devries	El Paso, Tex.
Elephant Butte Power Plant	Elephant Butte, N. Mex	C. O. Dale	Acting resident engineer	H. H. Berryhill	H. J. S. Devries	El Paso, Tex.
Riverton	Riverton, Wyo	H. D. Comstock	Superintendent	C. B. Wentzel	W. J. Burke	Billings, Mont.
Shoshone	Powell, Wyo	L. J. Windle	Superintendent [2]	L. J. Windle [2]	W. J. Burke	Billings, Mont.
Heart Mountain division	Cody, Wyo	Walter F. Kemp	Construction engineer	L. J. Windle [2]	W. J. Burke	Billings, Mont.
Sun River	Fairfield, Mont	A. W. Walker	Superintendent		W. J. Burke	Billings, Mont.
Truckee River Storage	Reno, Nev	Floyd M. Spencer	Construction engineer [2]		J. R. Alexander	Salt Lake City, Utah.
Tucumcari	Tucumcari, N. Mex	Harold W. Mutch	Resident engineer	Charles L. Harris	H. J. S. Devries	El Paso, Tex.
Umatilla (McKay Dam)	Pendleton, Oreg	C. L. Tice	Reservoir superintendent		B. E. Stoutemyer	Portland, Oreg.
Uncompahgre: Repairs to canals	Montrose, Colo	Herman R. Elliott	Construction engineer [2]	Ewalt P. Anderson	J. R. Alexander	Salt Lake City, Utah.
Upper Snake River Storage [4]	Burley, Idaho	Stanley R. Marean			B. E. Stoutemyer	Portland, Oreg.
Vale	Vale, Oreg	C. C. Ketchum	Superintendent		B. E. Stoutemyer	Portland, Oreg
Yakima	Yakima, Wash	J. S. Moore	Superintendent	Conrad J. Ralston	B. E. Stoutemyer	Portland, Oreg.
Roza division	Yakima, Wash	Charles E. Crownover	Construction engineer	Alex S. Harker	B. E. Stoutemyer	Portland, Oreg.
Yuma	Yuma, Ariz	C. B. Elliott	Superintendent	Jacob T. Davenport	R J. Coffey	Los Angeles, Calif.

[1] Boulder Dam and Power Plant.

[2] Acting.

[4] Island Park and Grassy Lake Dams.

Projects or divisions of projects of Bureau of Reclamation operated by water users

Project	Organization	Office	Operating official		Secretary	
			Name	Title	Name	Address
Baker	Lower Powder River irrigation district	Baker, Oreg	A. Oliver	President	Marion Hewlett	Keating.
Bitter Root [4]	Bitter Root irrigation district	Hamilton, Mont	G. R. Walsh	Manager	Elsie W. Oliva	Hamilton.
Boise [1]	Board of Control	Boise, Idaho	Wm. H. Tuller	Project manager	L. P. Jensen	Boise.
Boise [1]	Black Canyon irrigation district	Notus, Idaho	Chas. W. Holmes	Superintendent	L. M. Watson	Notus.
Burnt River	Burnt River irrigation district	Huntington, Oreg	Edward Sullivan	President	Harold H. Hursh	Huntington.
Frenchtown	Frenchtown irrigation district	Frenchtown, Mont	Tom Sheffer	Superintendent	Ralph P. Scheffer	Huson.
Fruitgrowers Dam	Orchard City irrigation district	Austin, Colo	S. F. Newman	Superintendent	A. W. Lanning	Austin.
Grand Valley, Orchard Mesa [3]	Orchard Mesa irrigation district	Grand Junction, Colo	Jack H. Naeve	Superintendent	C. J. McCormick	Grand Jctn.
Humboldt	Pershing County water conservation district	Lovelock, Nev	Roy F. Meffley	Superintendent	C. H. Jones	Lovelock.
Huntley [4]	Huntley Project irrigation district	Ballantine, Mont	E. E. Lewis	Manager	H. S. Elliott	Ballantine.
Hyrum [3]	South Cache W. U. A	Logan, Utah	H. Smith Richards	Superintendent	Harry C. Parker	Logan.
Klamath, Langell Valley [1]	Langell Valley irrigation district	Bonanza, Oreg	Chas. A. Revell	Manager	Chas. A. Revell	Bonanza.
Klamath, Horsefly [1]	Horsefly irrigation district	Bonanza, Oreg	Benson Dixon	President	Dorothy Eyers	Bonanza.
Lower Yellowstone [4]	Board of Control	Sidney, Mont	Axel Persson	Manager	Axel Persson	Sidney.
Milk River: Chinook division [4]	Alfalfa Valley irrigation district	Chinook, Mont	A. L Benton	President	R. H. Clarkson	Chinook.
	Fort Belknap irrigation district	Chinook, Mont	H. B. Bonebright	President	L. V. Bogy	Chinook.
	Zurich irrigation district	Chinook, Mont	C. A. Watkins	President	H. M. Montgomery	Chinook.
	Harlem irrigation district	Harlem, Mont	Thos. M. Everett	President	R. L. Barton	Harlem.
	Paradise Valley irrigation district	Zurich, Mont	C. J. Wurth	President	J. F. Sharples	Zurich.
Minidoka: Gravity [1]	Minidoka irrigation district	Rupert, Idaho	Frank A. Ballard	Manager	O. W. Paul	Rupert.
Pumping	Burley irrigation district	Burley, Idaho	Hugh L Crawford	Manager	Frank O. Redfield	Burley.
Gooding [1]	Amer. Falls Reserv. Dist. No. 2	Gooding, Idaho	S. T. Baer	Manager	Ida M. Johnson	Gooding.
Moon Lake	Moon Lake W. U. A	Roosevelt, Utah	H. J. Allred	President	Louie Galloway	Roosevelt.
Newlands [3]	Truckee-Carson irrigation district	Fallon, Nev	W. H. Wallace	Manager	H. W. Emery	Fallon.
North Platte: Interstate division [4]	Pathfinder irrigation district	Mitchell, Nebr	T. W. Parry	Manager	Flora K. Schroeder	Mitchell.
Fort Laramie division [4]	Gering-Fort Laramie irrigation district	Gering, Nebr	W. O. Fleenor	Superintendent	C. G. Klingman	Gering.
Fort Laramie division [4]	Goshen irrigation district	Torrington, Wyo	Floyd M. Roush	Superintendent	Mary E. Harrach	Torrington
Northport division [4]	Northport irrigation district	Northport, Nebr	Mark Iddings	Manager	Mabel J. Thompson	Bridgeport.
Ogden River	Ogden River W. U. A	Ogden, Utah	David A. Scott	Superintendent	Wm. P. Stephens	Ogden.
Okanogan [1]	Okanogan irrigation district	Okanogan, Wash	Nelson D. Thorp	Manager	Nelson D. Thorp	Okanogan.
Salt River [2]	Salt River Valley W. U. A	Phoenix, Ariz	H. J. Lawson	Superintendent	F. C. Henshaw	Phoenix.
Sanpete: Ephraim division	Ephraim Irrigation Co	Ephraim, Utah	Andrew Hansen	President	John K Olsen	Ephraim.
Spring City division	Horseshoe Irrigation Co	Spring City, Utah	Vivian Larson	President	James W. Blain	Spring City.
Shoshone: Garland division [4]	Shoshone irrigation district	Powell, Wyo	Paul Nelson	Irrigation superintendent	Harry Barrows	Powell.
Frannie division [4]	Deaver irrigation district	Deaver, Wyo	Floyd Lucas	Manager	R. J. Schwendiman	Deaver.
Stanfield	Stanfield irrigation district	Stanfield, Oreg	Leo F. Clark	Superintendent	F. A. Baker	Stanfield.
Strawberry Valley	Strawberry Water Users' Assn	Payson, Utah	S. W. Grotegut	President	E. G. Breese	Payson.
Sun River: Fort Shaw division [4]	Fort Shaw irrigation district	Fort Shaw, Mont	C. L. Bailey	Manager	C. L. Bailey	Fort Shaw.
Greenfields division	Greenfields irrigation district	Fairfield, Mont	A. W. Walker	Manager	H. P. Wangen	Fairfield.
Umatilla, East division [1]	Hermiston irrigation district	Hermiston, Oreg	E. D. Martin	Manager	Enos D. Martin	Hermiston.
West division [1]	West Extension irrigation district	Irrigon, Oreg	A. C. Houghton	Manager	A. C. Houghton	Irrigon.
Uncompahgre [3]	Uncompahgre Valley W. U. A	Montrose, Colo	Jesse R. Thompson	Manager	H. D. Galloway	Montrose.
Upper Snake River Storage	Fremont-Madison irrigation district	St. Anthony, Idaho	H. G. Fuller	President	John T. White	St. Anthony
Weber River	Weber River W. U. A	Ogden, Utah	D. D. Harris	Manager	D. D. Harris	Ogden.
Yakima, Kittitas division [1]	Kittitas reclamation district	Ellensburg, Wash	G. G. Hughes	Manager	G. L. Sterling	Ellensburg.

[1] B. E. Stoutemyer, district counsel, Portland, Oreg.
[2] R. J. Coffey, district counsel, Los Angeles, Calif.
[3] J. R. Alexander, district counsel, Salt Lake City, Utah.
[4] W. J. Burke, district counsel, Billings, Mont.

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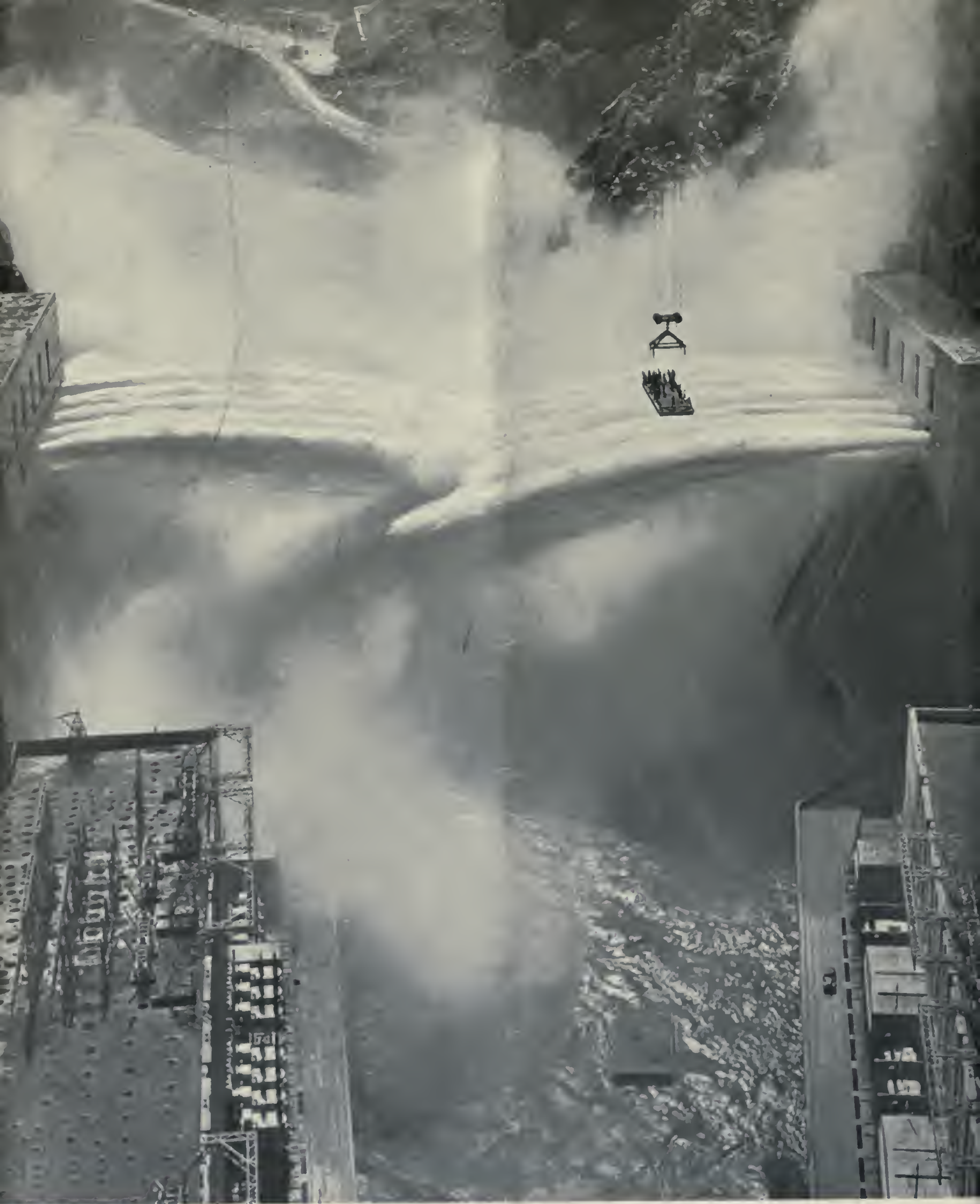
SALLIE A. B. COE, *Editor*.



CELEBRATING BOULDER DAM'S FIFTH "BIRTHDAY" BY TESTING ITS NEEDLE VALVES. INSPECTION FROM THE CABLEWAY PLATFORM IS QUITE A THRILL

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THE RECLAMATION ERA

DECEMBER 1940

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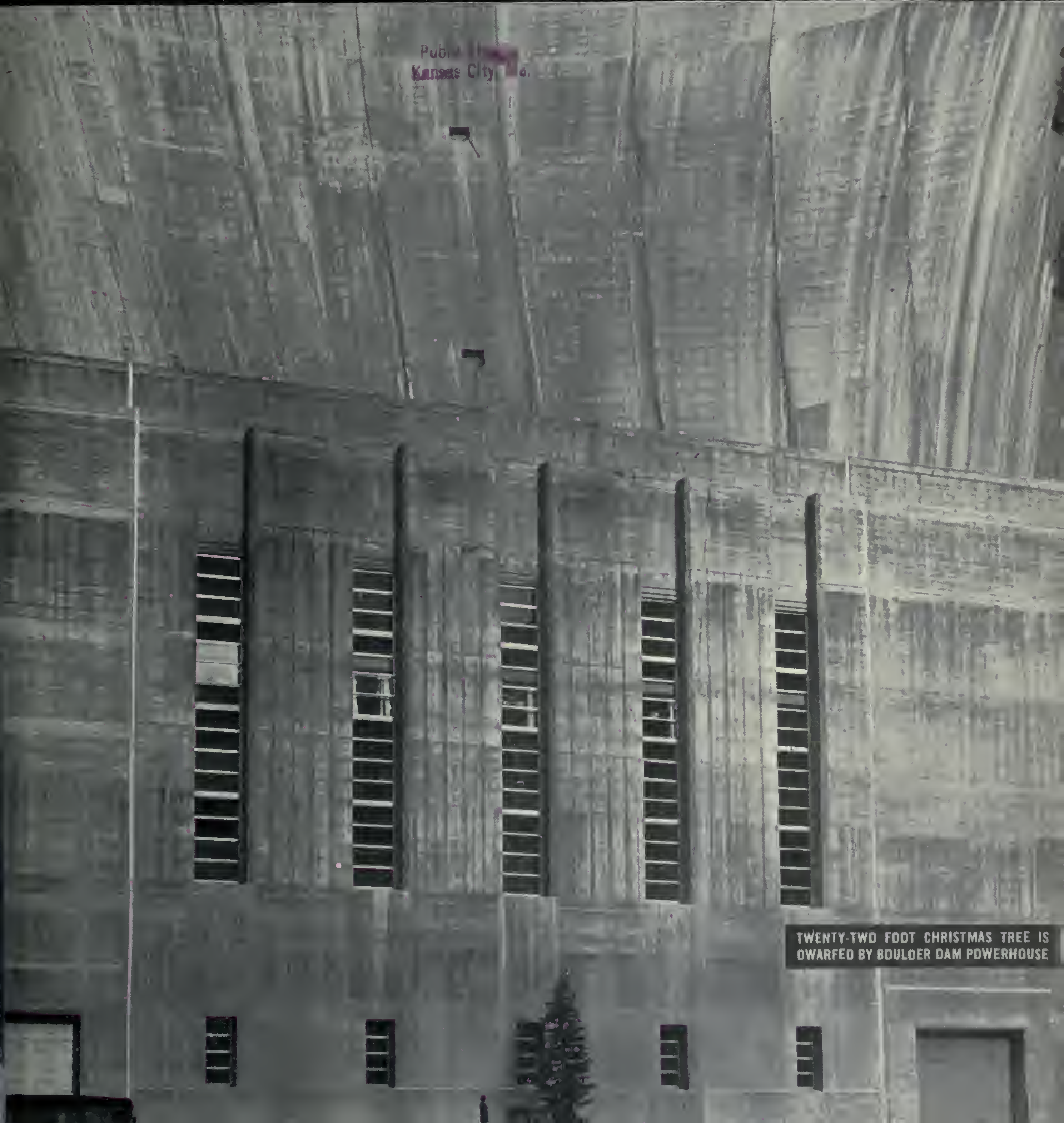
Kansas City



TWENTY-TWO FOOT CHRISTMAS TREE IS DWARFED BY BOULDER DAM POWERHOUSE

Holiday Greetings

IN THIS ISSUE, which should reach you before Christmas, I want to take this opportunity to extend Christmas greetings and the best of wishes for a happy and prosperous New Year.

To the personnel of the Bureau of Reclamation, to those persons and organizations laboring in the field of reclamation, and to the contractors I gratefully extend the season's greetings and thank you for the assistance and moral support you have rendered me during the past year in the administration of the Federal reclamation policy.

To the water users, permit me to state that your interests have been uppermost in my mind, and the spirit of cooperation in which you have worked with me and with Bureau representatives is reflected in increased confidence in the work of the Bureau of Reclamation, increased appropriations to carry on this work, and the record of achievement has brought about a wholesome appreciation of the Federal reclamation policy and the part it plays in the economics of the United States. The Department of the Interior has taken pleasure in making known this record through the medium of the press, literature, photographic exhibits, etc. May I ask and hope for this continued cooperation during the coming year?

To other readers of the *Reclamation Era*, hearty greetings and the promise of continued effort to bring to you during 1941 twelve attractive issues of this magazine giving you the story of reclamation.

JOHN C. PAGE,
Commissioner of Reclamation.

PRICE
ONE
DOLLAR
A YEAR

THE RECLAMATION ERA

VOLUME 30 • DECEMBER 1940 • NUMBER 12

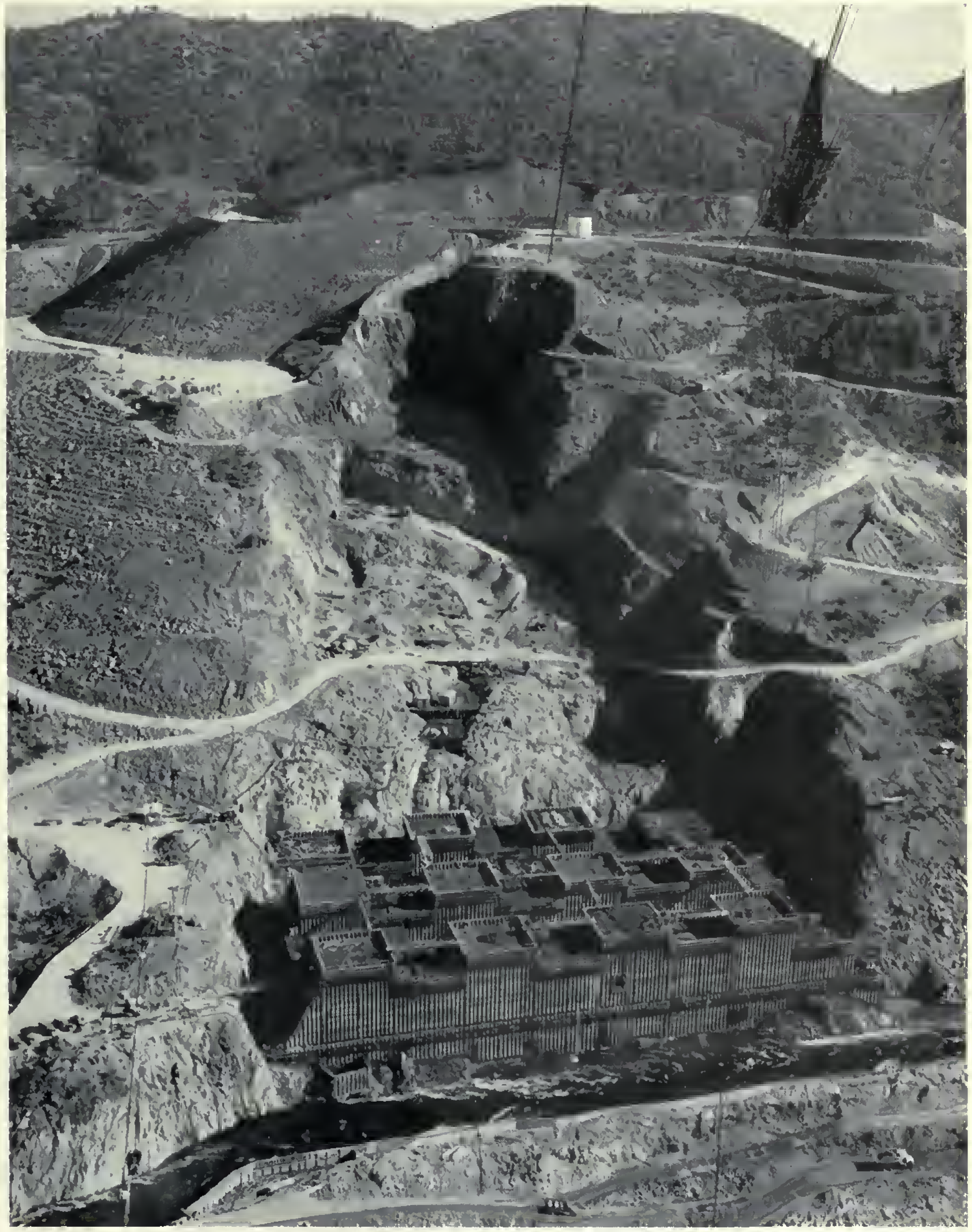
The Place of Shasta Dam in the Central Valley Project

By WALKER R. YOUNG, *Assistant Chief Engineer, Bureau of Reclamation*[1]

HISTORICALLY, the Great Central Valley of California has passed through three stages of development—from an original combination of desert and swamp lands when it was first occupied by white settlers, to a vast area of grain and cattle ranches in the wake of the gold rush, and now, under intensive irrigation, to an inland empire of diversified agriculture. It is not necessary to review, before this committee, the nature of the valley's water problem—a problem that has been a subject of study by various State and Federal agencies for more than half a century.

In considering the place of Shasta Dam in the Central Valley project, it is significant to note that, almost from the first investigation of the problem, it was recognized that a necessary major engineering feature of any solution would have to be a large storage dam on the Sacramento River, which is the principal source of water in the Central Valley. In designing the project it was necessary to consider it as the nucleus, or required minimum development, of a long-range plan for the conservation and utilization of the water resources of the entire drainage basin, and hence to correlate the project with the comprehensive State water plan envisioned for the future. Extensive hydrologic studies showed that the maximum justifiable limit for ultimate storage capacity on the Sacramento River, considering power return and economic benefits to the Central Valley, would be about 7½ million acre-feet, of which between four and five million were considered necessary in the initial development.

To obtain this storage capacity the Bureau of Reclamation investigated three potential



Before the close of September 1940, about 150,000 cubic yards of concrete had been placed in the left abutment of Shasta Dam reservoir sites in the upper Sacramento Valley—one with a dam at the Baird site on the Pit River 3 miles above its confluence with the Sacramento; one with a dam at the Shasta site on the Sacramento River 5 miles downstream from the mouth of the Pit; and one with a dam at the Table Mountain site on the Sacramento River about 10 miles north of Red Bluff. The Shasta site was selected in January 1937 as offering the best opportunity for satisfying the immediate requirements of the Central Valley project in the most economical manner under present conditions, and as properly fitting into the ultimate development of the State water plan. With a tributary drainage area of 6,665 square miles, Shasta Dam will back up the waters of the Sacramento, Pit, and McCloud Rivers a distance of 35 miles to create a reservoir with a gross storage capacity of 4,500,000 acre-feet.

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[1] Paper presented in Toyon, Calif., at meeting of California Central Valley-Central Coast Drainage Basin Committee of National Resources Planning Board. At time of its delivery Mr. Young was still supervising engineer of the Central Valley project.

Multiple Purposes of Central Valley

The Central Valley project has been fully authorized by the Congress for the following multiple objectives: (1) improving navigation on inland waterways; (2) reducing floods in the Sacramento and San Joaquin Valleys; (3) furnishing water for supplemental irrigation of areas in both valleys and in the upper bay region which are endangered by the exhaustion or inadequacy of local supplies; (4) providing river regulation for the control of salt water encroachment in the channels of the Sacramento-San Joaquin delta; (5) affording improved domestic and industrial water supplies; and (6) developing hydroelectric power for municipal, agricultural, industrial, and project use.

San Joaquin River harnessed at Friant dam site, Central Valley project

In accordance with those requirements, Shasta Reservoir will be operated to diminish the seasonal flood flows of the Sacramento River and thereby check annual waste to the sea of precious water, and correspondingly to increase the natural output of the river during the dry months for purposes of navigation, irrigation, and salinity control. The reservoir releases will be used also to generate electric power which will be carried by project transmission lines down the Sacramento Valley to load centers. Finally, after the conserved waters of the Sacramento River have served all these functions, and have passed every possible use on that river, they will afford a surplus for export to the upper bay region and San Joaquin Valley through other features of the Central Valley project.

These features include the Delta Cross Channel to divert Sacramento River water across the delta, Contra Costa Canal leading from the delta westerly to a bayshore industrial and agricultural area, San Joaquin Pumping System extending from the delta into the northern San Joaquin Valley, Friant Dam on the upper San Joaquin River, and Friant-Kern and Madera Canals to serve the southern San Joaquin Valley. It should be noted that all of these are dependent, directly or indirectly, upon Shasta Dam—and in fact no one of the Central Valley project features can be utilized to full advantage until some other or all of the features are in operation.

Friant Due for Completion in 1943

For instance, under the present construction program Friant Dam is to be completed in 1943. Except for a certain amount of flood control, it will be of little value until its connecting canals can be constructed to the areas of critical water deficiency—particularly the long Friant-Kern Canal under which more than half the service area of the project is located. However, since the rights to store water in Friant Reservoir are being obtained in part through an exchange of water to be effected by the San Joaquin Pumping System, the Friant-Kern Canal cannot be placed in operation until completion of the pumping system for the importation of water released from Shasta Reservoir.

It happens that under existing conditions the entire normal flow of the San Joaquin River already is appropriated for irrigation in the northern end of the San Joaquin Valley. Before sufficient San Joaquin River water can be held back at Friant for diver sion to needy lands under the Friant-Kern and Madera Canals, a substitute supply must be furnished the present water users along the lower San Joaquin River. The plan is that this substitute supply will be brought from the more abundant Sacramento River through the San Joaquin Pumping System, which, therefore, is vitally appurtenant to Friant Dam and the Friant-Kern and Madera Canals.

Similarly, an adequate water supply cannot be made available at the intake of the San Joaquin Pumping System until completion of the Delta Cross Channel leading from the Sacramento River. The Cross Channel also is necessary to facilitate salinity control in the delta and to introduce a fresh water supply to the intake of the Contra Costa Canal. But before any substantial quantity of water can be diverted in the delta region through any of these features—the Cross Channel, San Joaquin Pumping System, or Contra Costa Canal—Shasta Dam must be in operation so as to conserve and regulate the flow of the Sacramento River and thereby assure a year-round water supply for the various project uses.

It may be noted that although a completed portion of the Contra Costa Canal now is in operation, delivering to Pittsburg such water as is available at the canal's delta intake, the quality of this supply is not assured, and in fact the supply is subject to failure until the completion of Shasta Dam.

The only exception to the absolute interdependence of the project features is Shasta Dam itself, which obviously is the key structure of the Central Valley project, for, in summation, Friant Dam and the Friant-Kern and Madera Canals cannot be placed in normal operation until the San Joaquin Pumping System and Delta Cross Channel are completed, and in turn these and the Contra Costa Canal cannot function properly until Shasta Dam is completed.

In the 38-year history of the Bureau of Reclamation, during which it has constructed 148 dams to conserve water and regulate stream flows, no project has had promise of greater potential benefit than the Central Valley project. An outstanding example of a multiple-purpose project, it is of major importance nationally as well as locally in the conservation and development of the water and power resources of one of the country's most important agricultural areas. It meets the modern demand of a conservation-minded nation that maximum benefits be made to flow from public expenditures for stream improvements.

Friant: A Modern Construction Community

By A. R. HINES, *Safety Engineer, Friant Division, Central Valley Project*

AUTOMOBILE commuting by the majority of construction workers—county control of boom towns and squatters—an attractive Government camp—

These are features of the modern construction community of Friant, Calif., located on the upper San Joaquin River 20 miles north of Fresno and 20 miles east of Madera.

Early in 1936, the Bureau of Reclamation gave consideration to the location of a camp to house the resident personnel required in connection with the construction of Friant Dam, a feature of the Central Valley project. After investigating several sites, the Bigelow Tract in Fresno County was chosen. This tract originally was incorporated in the town site of Friant as the Polaski Addition. The 50-acre camp site is located on a flat bench on the east side of the river adjacent to the town of Friant and elevated some 50 feet above the business center. This commanding topographic location allied with the protection afforded by surrounding hills, eliminated to a large extent the problem of encroachment by the mushroom growth of boom towns with the attendant undesirable consequences encountered at many large construction projects. Added controlling factors were accessibility to a Southern Pacific railroad branch, a telegraph office, main paved highway from Fresno, and approach to the site of Friant Dam, some three-quarters of a mile distant.

In May 1936, topographic surveys and a preliminary lay-out of the camp were completed. Actual construction was started in May 1937 with the awarding of the first housing contract for 25 duplex cottages. This program was followed by construction of an office building, 2 dormitories, and 28 additional residences ranging from 2 to 6 rooms in size. A water storage tank, a sedimentation reservoir, pumping plant, sewage-treatment plant, large garage, and a concrete testing laboratory were constructed and all were practically completed by January 1938.

R. B. Williams, construction engineer, Friant Division, Central Valley project, California

Government Camp and Accommodations

The original lot lines as staked out in the Polaski Addition were revised and a new plat system, meeting the requirements for a Government camp, was established. The street plan is a typical gridiron pattern with a traffic circle at the south end of each principal avenue. A plan of landscaping was initiated with extensive planting of trees, shrubs, lawns, and flower gardens grouped around the administration, dormitory, shop buildings, and family residences. The water supply is pumped from the San Joaquin River at a point about one-half mile north of camp, where two 250-gallon per minute electric motor driven pumps are located. The water is pumped directly to a 2,660,000-gallon sedimentation and storage reservoir where two additional pumps raise the water into the 100,000-gallon tank, located 115 feet above the general camp area, for distribution into the camp mains. The water is sterilized by two chlorinating units located within the storage basin.

A sewage-treatment plant was constructed about one-half mile south of Friant. The plant is composed of an Imhoff tank, trickling filter, and evaporating ponds designed to accommodate the camp population. Electricity is purchased from the San Joaquin Light & Power Co. by each individual consumer. Each residence is supplied with a butane gas cooking unit and hot-water tank. A storage tank of 6,065-gallon capacity supplies the liquid petroleum used for generating the butane gas. However, most of the householders elected to heat by fuel oil as it has proven to be suitable as well as economical for the San Joaquin Valley climate. As temperatures well over 100° F. are prevalent throughout the summer, the office and dormitory buildings are air-cooled and most of the residents have installed evaporating air or desert-type coolers as part of their home equipment.

A typical street scene in the Government camp, showing landscaping and residences

School Accommodations

Supplementing the existing Friant School, the general contractor in cooperation with various school districts constructed additional building quarters in the towns of Friant and Clovis, and in Madera County, for the grade-school children whose parents are employed on Friant Dam. High-school students are transported by bus to the Clovis High School 12 miles distant.

Construction of Friant Dam began in November 1939. The Government camp residences are now about 95 percent filled, with a total population of 202. It is expected that later this year all residences will be fully occupied, and that married workers employed later will find it necessary to live outside the Government camp.

Contractor's Camp and Accommodations

The contractor's main camp is located three-fourths of a mile above Friant Camp and just downstream from the dam site on the left bank of the San Joaquin River. The camp consists of an administration building for Griffith Co. and Bent Co., two 48-man dormitories, a mess hall accommodating 120 persons, and a well-equipped hospital and first-aid station. The camp water supply for public consumption is furnished by a 750-gallon per minute pump located in the construction plant pump structure upstream from the dam site. The water is chlorinated at that point and pumped into a 40,000-gallon tank provided for camp distribution. The contractor constructed six 5-room residences above the north end of the Government camp for the families of the various job superintendents. The offices, dormitories, mess hall, and resident homes are all provided with air-cooling systems.

Because the majority of the construction workers live elsewhere and commute to work, the contractor at Friant was relieved of the necessity of erecting a large housing camp. Some 500 employees with their families live in the city of Fresno and travel by automobile about 40 miles each day. At least 100 employees live in the vicinity of Clovis and commute a distance of 25 miles to work. The remaining 400 or more employees live in the town of Friant in the many auto camp type buildings and trailer camps located on both sides of the river as far as 5 miles downstream from the dam site.

While the housing requirements were minimized for the contractor, it was necessary to provide large automobile parking areas to accommodate the stream of daily commuters. The contractor constructed 3 separate but interconnected parking areas on different levels just inside the main gate entrance to the construction site. These are served by a 1-way road leading into each parking space with the exit roadway discharging cars onto the Auberry Road. The 3 separate parking areas provide space for 175 cars during the day shift, while for the "swing" and "graveyard" shifts about 100 cars can be parked in each area. The areas are well marked with traffic signs. The space provided for the 12 midnight to 8 a. m. shift has this one for Mr. Ripley: "Graveyard Park Here." While each worker uses the area especially provided for his shift, the daytime parking space is sufficient in size to take care of any overflow from the other shifts. The present parking facilities and traffic routing have proven to be satisfactory for the safe and adequate handling of the large daily auto traffic.

Control of Boom Camps and Squatters

The Bureau of Reclamation initiated preliminary steps directing the attention of the

Contractor's messhall and dormitories, auto parking areas, and some residences

Fresno County Planning Commission and health and police officials of Madera and Fresno Counties to the desirability of cooperating to prevent bad housing and sanitation conditions likely to arise in the immediate vicinity of Friant Dam. Several meetings were held and Dr. L. A. Stone, director of the Madera County health unit, was delegated to make an investigation of similar situations. Accordingly he spent several days in the area around Shasta Dam and compiled a report for guidance of the local authorities. On May 9, 1939, an ordinance was adopted by the board of supervisors of Madera County regulating the construction, sanitation, and conduct of house courts and tent space; providing for the issuance of permits for their operation; and prohibiting squatter camps in the unincor-all of which are under the supervision of the health officer. The health officer investigates all matters pertinent to the granting of permits and conducts monthly inspection trips to camps.

County Assists in Control

By county action, squatter camps were declared a public health nuisance and, where found, are promptly ordered out of the vicin-porated areas of that county. This ordinance gave the board the specific power to grant permits to individuals who planned to build and operate tent camp spaces and house courts, ity. Through this early program of providing suitable methods for controlling the building and sanitation of all temporary structures, the local officials have succeeded in keeping the general living conditions above the par of other similar boom communities. This fact, coupled with the contractor's practice of employing a large proportion of permanent San Joaquin Valley people who live with their families in well-built homes in this area, has created for the most part a well-regulated construction community which is very desirable in connection with any construction job.

Contra Costa Canal in Operation

By GARFIELD STUBBLEFIELD, *Engineer*

THE first delivery of water from the Central Valley project took place at Pittsburg, Calif., on August 18, 1940, when a turn-out gate was opened to release water from the Contra Costa Canal to the city's water main. Pittsburg is an industrial city of about 12,000 population located in the upper bay region 40 miles east of San Francisco.

It is not possible to visualize the importance to the community of this new supply without a knowledge of the critical condition which has resulted from a draft on the ground water supply greatly in excess of natural replenishment. Municipal and industrial wells in the vicinity have so lowered the ground water levels as to threaten the exhaustion of a potable local supply. The hardness of the well water supply for Pittsburg increased from a total of 150 parts per million in 1929 to approximately 800 parts per million in 1940.

On account of this situation, the city of Pittsburg and the Columbia Steel Co. prevailed upon the directors of the Contra Costa County Water District to enter into a contract with the United States to deliver water on a preliminary basis as soon as it became feasible to do so. Thus a portion of the Central Valley project has gone into operation several years ahead of original expectations. The district acts only as an intermediary and requires the city of Pittsburg and the Columbia Steel Co. to pay the entire cost so long as the canal is operated for their exclusive benefit.

Pittsburg has four wells 225 feet in depth from which an average of 700,000 gallons per day were pumped against a head of 180 feet to the treatment basin from a ground water elevation about 100 feet below sea level. Last year Pittsburg constructed a modern purification plant for the treatment of water from the Contra Costa Canal. It has four pressure filtration units with a combined capacity of 2,600,000 gallons per day.

The Columbia Steel Co., a subsidiary of United States Steel Corporation, obtained an average of 2,000,000 gallons per day from four wells which have a depth of approximately 200 feet. Canal water now is being substituted for this well supply. No change is contemplated for the present in the company's supply for certain industrial processes which use water pumped directly from the San Joaquin River. Drinking water for the plant is obtained from the city of Pittsburg.

The partially completed Contra Costa Canal is the first feature of the Central Valley project to go into operation. This section of the canal supplies supplementary irrigation to orchards and vineyards near Oakley, Calif.

Aerating basin through which fresh water from the Contra Costa Canal is delivered to the city of Pittsburg

Left to right: Frank Chilton, of Pittsburg, Calif., manager; R. L. Heck, superintendent, Municipal Water System; O. N. Christianson, secretary, Contra Costa County Water District; O. G. Boden, construction engineer, ready to open the Pittsburg turn-out gate; and Richard A. Young, engineer

To celebrate the bringing in of a new and improved domestic and industrial water supply, Pittsburg held a 3-day "Water Fiesta" on October 11, 12, and 13, including day and night parades, an historical pageant, athletic events, and school festivities.

The Contra Costa Canal is a feature of the multiple-purpose Central Valley project, and upon the completion of Shasta Reservoir on the upper Sacramento River 200 miles to the north, it will be assured of an all-year supply of fresh water. Conserved water will be diverted from the lower Sacramento River and conveyed across the Sacramento-San Joaquin Delta to the canal intake at Rock Slough, near Knightsen. The canal at its intake has a capacity of 350 cubic feet per second which is reduced in the 46-mile length to 72 cubic feet per second at its terminus at Vine Hill Reservoir near Martinez. The canal is designed to serve at least 30,000 acres of agricultural and suburban residential areas, in addition to the industrial and municipal regions between Antioch and Martinez.

The first 20 miles of the canal have been completed to a point about 4 miles beyond Pittsburg. Pumping equipment has been installed to handle 60 percent of the designed canal capacity. An additional 9-mile section of the canal is under construction to a point about 2 miles northeast of Concord. The 4 pumping plants located between mile 4, near Oakley, and mile 7, near Neroly, lift the water from approximately sea level to an elevation of 124 feet.

Capacity of Plants

An initial capacity of 210 cubic feet per second for the first 3 pumping plants and of 198 cubic feet per second for the fourth plant is provided by two 70- and two 35-cubic-foot-per-second units installed at plants Nos. 1, 2, and 3, and by two 66- and two 33-cubic-foot-per-second units at plant No. 4. Provision has been made in each plant for ultimate installation of two more large units.

Numerous other structures were required in the first 20 miles of the canal which traverses a thickly settled area. Prominent features include the headworks structure near Knightsen, a tunnel 1,360 feet in length near Neroly, two railroad crossings, 14 reinforced concrete siphons under roads and drainage courses, and the Los Medanos Wasteway 1.7 miles in length which diverts from the canal near mile 14. There are 120 other structures along the canal and 9 along the wasteway. Only the first 3.7 miles of the canal leading to the first pumping station are unlined. The first construction work was started October 19, 1937, on the upper section. Pump testing was begun July 8, 1940.

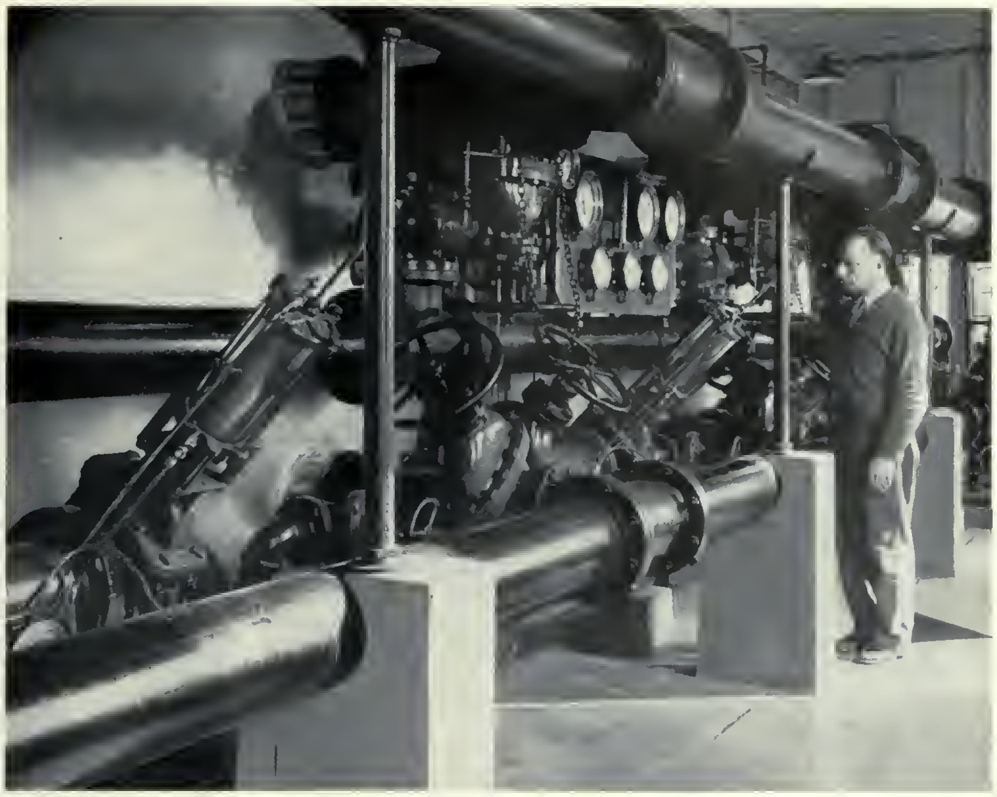
Careful consideration was given to the design to temporary structures for the control of the water to be delivered under the temporary water service contract. Spillway control of the water level above a check located a short distance west of the Pittsburg turn-out is provided by a temporary weir at the head of the Los Medanos Wasteway, about 2½ miles east of the Pittsburg turn-out, having its crest at an elevation 20 inches below the top of the lining at the canal check. The pool back of the Pittsburg turn-out extends 5 miles up the canal to a temporary control structure at another canal check which forms a second pool extending about 4 miles up to the outlet from Pumping Plant No. 4. Water from this upper basin is automatically released into the lower one as the latter is drawn upon so that the lower water level is held approximately constant so long as an ample stored supply is available. The combined capacity of the two pools is about three times the maximum daily draft of 13 acre-feet contemplated under the temporary water service contract, which allows considerable latitude in the operation of the pumping plants.

Use of this storage makes it possible to operate the pumping equipment to take advantage of the low cost for electrical energy which is secured by limiting the use to "off-peak" hours which are between 10:30 p. m. and 6:30 a. m. and on Sundays and holidays. A daily pumping period of less than 6 hours with one of the small units, or 3 hours with one of the larger units, at each pumping plant provides the daily water supply of 13 acre-feet, with a liberal allowance for losses including evaporation and seepage.

The pools between the pumping plants are being kept approximately filled. The drop in the water level between plants is almost negligible for small flows, although the combined drop with full capacity for the three reaches amounts to 3¾ feet. Beyond Pumping Plant No. 4 the canal water surface, with but one of the larger pumping units being operated, is about 4 feet below the full capacity water surface elevation.

The greater portion of accumulated ground water which was standing in the earth section of the canal back of Pumping Plant No. 1 was pumped out and wasted through the Los Medanos Wasteway before fresh water was diverted into the canal from Rock Slough on August 9.

Electric power for the interim operation is being supplied by the Pacific Gas & Electric Co. under a contract with the Contra Costa County Water District. Under eventual operation of the Central Valley project, power required to operate the Contra Costa Canal pumps will be supplied from Shasta Dam.



New municipal water plant. The filtration house has 4 units with a combined capacity of 2,600,000 gallons a day

All-Americans in Imperial Valley

By J. R. LAWRENCE, *Division Engineer, and* C. WHITE, *Associate Engineer*

LEST anyone be deceived by the title of this article, it should be stated that the phrase "All Americans" refers neither to a basketball, nor a baseball, nor a football team. The team in question does not consist of 5, or 9, or 11 players—its members are numbered in the thousands. It includes all those individuals who had a part in the construction of the All-American Canal, soon to supply the Imperial Valley of California with domestic and irrigation water from the Colorado River.

As indicated by the title, this largest of California's irrigated valleys was the "playing field" trod by our "All-Americans" in the struggle to complete the new canal before the final gun. Also included in this "playing field" of one and a half millions of acres was the adjacent East Mesa area, lying along the eastern border of the valley; some 200,000 acres of this tract of arid land will be watered eventually by the new canal.

The first workers to become members of the All-American construction team were the surveying crews who made the final location and drove the cross-section stakes to which the canal was dug. Then came the "mule skinners" with their "four-ups," breaking the ground with heavy plows and hauling it to the canal embankments with fresno scrapers—possibly the last big relief excavating job in the United States to be done by this method, now made obsolete by "dragline" excavators. The Colorado River had gone practically dry during the late summer of 1934, causing a severe drought affecting all of Imperial Valley. This was the Colorado's last defiant gesture, as it were, before coming entirely under man's control with the completion of Boulder Dam. As an emergency drought relief measure, the force of 1,200 mules and 300 men, residents of Imperial Valley, was given the chance to become "All-Americans."

Summer Slackens Work

Although it is possible for animals and men to work throughout an Imperial Valley summer, their efficiency is unavoidably lowered; hence, our "All-Americans" found it advisable to discontinue operations during the 4 months from June to September, inclusive. The high temperatures experienced in this area during the summer are accompanied by low relative

Above: 16-cubic-yard bucket of Monighan walking dragline dumping load on canal embankment

Below: Standard-size sedan inside 12-cubic-yard dragline bucket

humidities, so that the climate is not injurious to health. It is only fair to state that our "All-Americans" find compensation in Imperial Valley's winter climate for the discomforts of the summer season. In fact, increasing numbers of winter vacationists are discovering that Imperial Valley from November to May leaves nothing to be desired in the way of climate.

Within 2 years our "All-Americans" of the team and fresno had completed their share of work on the largest of the world's irrigation canals; they had dug a channel some 20 miles long across Imperial Valley from east to west, just north of the international boundary which separates the United States and Mexico. It was necessary to leave short sections of the new canal unexcavated where laterals of the existing water-delivery system crossed over into the United States from Mexico. Until the entire All-American Canal system is complete and ready for operation, Imperial Valley must continue to receive its supply of domestic and irrigation water through a main canal flowing for over 50 miles through a foreign country. The unavoidable hazards of national differences and labor troubles, as well as the high cost of silt deposal under the existing system, were major factors leading to the construction of this new canal entirely within the United States and appropriately named "All-American."

Following the team and scraper "All-Americans" came an entirely different sort of team, using highly mechanized equipment—the contractors with their big draglines and bulldozers, finishing up sections of canal not adapted to mule and fresno methods. Short sections of canal east of Calexico were found too wet to be completed by teams; and the 23-mile reach of canal crossing the East Mesa area was a construction job not only too large and difficult, but too expensive for teams to complete within a reasonable time. Hence, giant walking dragline excavators, with buckets large enough to hold a light truck, and with sufficient reach to pick up the vehicle at one end of a city block and set it down at the other were used.[1]

Permanent Structures

With the completion of the canal excavation, still another group of "All-Americans" came into action—the contractors who were awarded jobs building the permanent structures for the canal. These structures included highway bridges and siphons for road crossings near Calexico; the New River Siphon northwest of Calexico; the power drops between Calexico and the sand hills and numerous smaller structures. The more important of these works have been described in previous Reclamation Era articles.

Work on the irrigation structures that will connect the present Imperial Valley distribution system with the new canal was started late in 1937 and continued through 1938 into 1939. The first job to be done on these contracts was the construction of temporary flumes and pipe-line crossings of the All-American Canal to maintain uninterrupted service through the existing lateral system carrying water northward to the valley from Mexico. This called for "All-Americans" of the hammer and saw, and of muscle—the carpenters and labor gangs. After these temporary crossing structures were completed, the All-American Canal "plugs" were removed, with no interruption in water deliveries through the existing system. When water is available from the new canal, these temporary structures will in turn be removed and service rendered directly from the new turnouts. This change can be effected within a short period of time, causing no inconvenience to water users. Wooden flumes, supported on timber bents, were used for the temporary crossings wherever practicable. At several locations, where intermittent operation of the laterals was necessary, metal flumes were used to minimize leakage. At other crossings, where the structure would later be completely submerged during the priming of the All-American Canal, steel pipe lines supported on timber bents were used. Required capacities for the structures in this group ranged from 10 to 300 cubic feet of water per second.

In several cases, it was found practicable to construct the permanent turn-out structure for the new canal before erecting the temporary crossing. The outlet of the temporary flume or pipe line was later connected directly to the inlet of the concrete turn-out structure and deliveries made to the water user through the new and permanent turnout structure. This will result in a minimum of time and work required to change over to the new source of supply when All-American Canal water is available.

Crossing structures were provided for all except two of the large canal systems intercepted by the All-American Canal in its westward flow across the valley. These two systems—the East Highline Canal on the eastern border of Imperial Valley, and the Allison Heading network some 3 miles farther downstream—were so large that the advantage to be gained by removal of the material in these "plugs" could not justify the cost of the crossing structures. A considerable volume of material also remains to be excavated from the All-American section along a length of some 1½ miles northeast of Calexico, where the new canal parallels the existing Central Main Canal. Therefore, the excavation for the new canal will not be entirely completed until just before it is ready to go into operation.

With the beginning of construction on the permanent structures of the new main canal, still another group of "All-Americans" came into the game: reinforcement steel workers, cutting, bending, and placing steel to fit the structure; concrete gangs, mixing, and plac-

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[1] For the technically minded: The bucket capacity for the 10-W Monighan dragline operating in loose sand was 16 cubic yards, with boom length of 175 feet, giving a total reach of almost 350 feet.

Turn-out and 3-way division structure at Allison Heading, 9 miles east of Calexico

Metal flume carrying Alamitos Canal across All-American, with dragline removing "plug"

ing concrete in the forms constructed by the carpenter crews; laborers using high-speed vibrating and tamping equipment to insure concrete of maximum density and strength. Most of this concrete was placed during the winter months, but a considerable amount also was placed during May and June when atmospheric temperatures rose to 100° F. during the day; however, concrete was placed at night during these periods in order to take advantage of lower temperatures. The aggregate stockpiles were watered several hours before concrete was to be placed, to permit evaporation to cool the aggregates. By this method, concrete temperatures during placing operations were kept below the allowable maximum of 90° F., as required by specifications.

Several interesting construction problems were solved by our "All-Americans" during the building of these permanent structures. Perhaps the most troublesome problem in the East Mesa area was the lack of a supply of water for concrete mixing and curing operations. Tank trucks were found to be the solution, water being hauled by this means as far as 15 miles. Another problem in this area resulted from the absence of roads for hauling materials and equipment to the structure sites. For some locations, gravel roads were built and maintained. For locations where their short-time use made even temporary roads uneconomical, another "All-American" was called into action—the "cat-skinner" with his big caterpillar tractor. These machines encountered no difficulty in pulling heavy loads through deep sand. Thousands of tons of aggregates, cement, and reinforcement steel were hauled from the highway to structure sites by this method; in many cases where loaded trucks were unable to reach their destinations under their own power, "cats" gave them the needed assistance.

Foundation Work

In direct contrast to the problem encountered on the East Mesa due to lack of water was the difficulty encountered in the irrigated section due to a high water table. To facilitate foundation work, several structure sites were provided with pumping equipment. At others, sheet-piling was driven around the area to be excavated, and pumps were used only when water conditions became troublesome. A layer of pit-run gravel from a few inches to a foot or more in thickness, placed as a subbase for the concrete foundation slabs, proved very successful in controlling the ground-water elevation during construction. Drainage from the subbase areas was disposed of by pumping.[2] These methods were followed at the Alamo River Crossing, at the New Briar Canal crossings of the All-American, and at the Central Main Check and Turn-out. All of these structures have points of interest worthy of special attention.

This is especially true of the Alamo River Crossing which carries the new canal across an old flood channel some 7 miles east of Calexico, at a point just north of the international boundary. When the Colorado River became unmanageable in the years 1905 and 1906, a large part of Imperial Valley was inundated by the flood waters flowing northward to the Salton Sea; before the river's flow could be turned back into its natural outlet to the Gulf of California, the small flood channel had been converted into a cut which at points was a quarter mile in width and 30 feet deep. The present channels of both the Alamo and New Rivers were formed in this manner; although both are products of the Colorado's destructive activity, they have since proved to be constructive influences in the development of Imperial Valley, serving as wasteway and drainage channels. Recent issues of the Reclamation Era have carried articles describing the structures used as All-American Canal crossings of these two channels.

The New Briar Canal Crossing, some 4 miles downstream from the Alamo Crossing, is a structure with several unique construction features. Its design includes a double-barrel reinforced concrete conduit with a top slab which serves also as the deck slab for a highway bridge. The canal and road transitions are so located that there is no interference between the dual functions of the structure; the conduit will convey 350 cubic feet of water per second from the New Briar Canal on the right of the All-American to the same canal on the left, at a water surface elevation 10 feet above that of the All-American. The bridge serves as a county road crossing. The entire center section of the combined structure is designed as a single unit 128 feet in length, with no joints except at the ends; here flexible rubber water seals are provided and serve as expansion joints between the abutments and the center section. Two concrete piers support the middle part of this center unit and the ends are supported by steel rollers resting on the concrete abutments.

After paralleling the All-American for 1½ miles, the New Briar crosses back to the right side through a structure similar to the one just described. The conduit and bridge section is designed in combination with the Central Main Check structure, which provides regulation for the adjacent Central Main Turn-out. In order to insure uninterrupted

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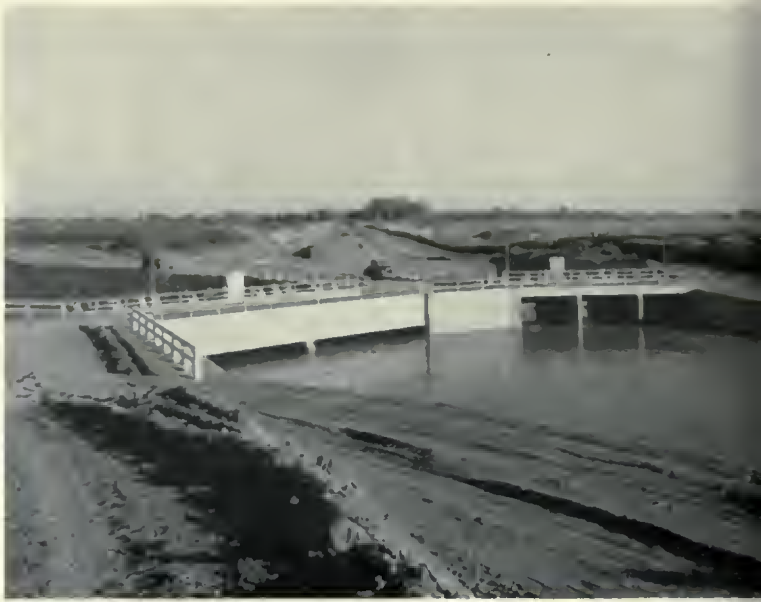
[2] The installation of weep-pipes, extending from the gravel layer through the floor and foundation slabs, insured the structure against any possibility that future ground-water conditions might develop hydrostatic pressures endangering the stability of the structure.

"Four-mule-power" fresno scrapers at work on new canal across Imperial Valley, just north of International boundary



Central Main Check and Turn-out; at left, new Briar Canal crosses All-American in conduit beneath floor of operating bridge over check structure. Water supplied through Mexico is flowing from All-American channel through Central Main Canal Turn-out structure at right

service through the existing Central Main Canal during the construction period, a detour channel was provided entirely outside of the location of the new structures.

The city of San Diego, Calif., has contracted for a right to 155 cubic feet of water per second from the All-American Canal. At some future date, when the city needs this additional supply of 100,000,000 gallons a day, an extension of the All-American will be constructed; pumping plants and conduits will then convey the water into the existing San Diego distribution system. The All-American, as designed and constructed to the western boundary of the present irrigated area, also provides for bringing under irrigation an additional 126,000 acres of land on the West Mesa; this area is somewhat higher in elevation than the East Mesa and will require pump lifts.

It was necessary to provide several low-lift pump installations of small capacity to irrigate a few hundred acres of high land west of Calexico. Comparative estimates had shown the total pumping costs to be much less than the cost of the additional earthwork involved in carrying the All-American at the higher elevation necessary to irrigate these lands by gravity. Electrically operated screw-type vertical pumps were employed, with capacities ranging from 5 to 10 cubic feet of water per second, under heads of 3 to 9 feet. Sheet-metal housings completely enclose the motor units, affording weatherproof protection. The pumps were installed in reinforced concrete structures and will discharge directly into existing laterals supplying the high land.

Workers by Proxy

The story of our "All-Americans" in Imperial Valley would not be complete without reference to a group of workers who may be called "All-Americans" by proxy. Included in the group are all those individuals who supplied the construction equipment and materials that made the new canal a reality. Working in mills, mines, shops, oil fields, or factories in half the States of the Union, they contributed their share toward the completion of a job of which they may never have heard. Automobiles, trucks, tractors, concrete mixers, draglines—these were but a few of the largest units from the list of hundreds of items of equipment used and worn out in building the All-American. Among the materials that went into the finished structures were: hundreds of carloads of sand and gravel, washed and graded ready for use; thousands of sacks of Portland cement from plants in southern California; millions of pounds of reinforcement steel, as well as hundreds of tons of steel gates and structural steel, from mills in Colorado and the East; lumber by the carload from the forests of Washington and Oregon.

In order to complete the picture of our All-American team, the "coaching staff" deserves at least honorable mention; this consisted of the personnel of the Bureau of Reclamation by whom the activities of the various units making up the team are directed and coordinated. Although a large force of stenographers, clerks, and other clerical workers are an indispensible part of the staff, engineers predominate in the organization; they serve in many different capacities: On survey crews, staking out the exact locations of canals and structures; as inspectors, checking all details of the work and seeing that it complies with specifications; as materials men, checking over all materials and equipment furnished to the Government; and as computers and office workers under the direction of the office engineer keeping account of the progress of the work and of the monthly payments due each contractor. The fact that this coaching staff in itself numbered several hundred men at the peak of activity serves to indicate the magnitude of the job performed by the All-American team.

Nine Generators Now Operate at Boulder Dam

BOULDER DAM'S canyon wall outlets were opened on September 28, and the occasion was an informal observance of the fourth anniversary of power generation at the project, which is now supplying more than 50 percent of the power consumed in the metropolitan area of southern California. The huge needle valves were put through their paces during an annual test, and the great volume of water released had a fall from a height 13 feet greater than that of Niagara Falls.

Nine generators are now in operation at Boulder Dam and three more are on order. The powerhouse has space for 17 generating units.

Twelve canyon wall outlet needle valves, six on each side of the Colorado River, were involved in the test. Each is capable of releasing about 5,000 cubic feet of water per second—a young river.

Construction Methods and Progress on the Coachella Branch of the All-American Canal

By J. R. LAWRENCE, *Engineer*

THE Coachella Branch of the All-American Canal is located in the southeastern part of California and originates on the All-American Canal, approximately midway between Yuma, Ariz., and Calexico, Calif.

This branch of the canal not only will provide water for the irrigation of some 195,000 acres of desert lands which lie to the east of Imperial Valley's irrigated section, but it will assure also an adequate irrigation supply for lands in the Coachella Valley. This latter valley at one time was irrigated by means of artesian wells, but with continual use of water from these wells the water table has been lowered to such an extent that pumping is now necessary. The increasing cost of pumping operations incidental to the increased pumping head has made it essential that a more economical source of supply be obtained.

From a turn-out on the All-American Canal, the Coachella Branch proceeds in a northwesterly direction along the western edge of California's sandhills. Then the route passes between the foothills of the Chocolate and Orocopia Mountains, and the Salton Sea, following approximately the ancient beach line to the north tip of the Salton Sea. Here the Coachella Valley begins and the irrigable area lies between two high line canals on the east and west sides of the valley.

Canal excavation on Division No. 1, which includes the first 40 miles of canal line, was completed in March 1940. Contracts for the building of structures along this reach of the canal will be awarded at a future date.

A contract was awarded to Morrison-Knudsen Co., Inc., and M. H. Hasler in September 1939 for the completion of Division No. 2. This division is also approximately 40 miles in length. The contract provided for the building of structures along this section of the canal, as well as the excavation of the canal and diversion and drainage channels.

The construction of this reach of canal involves many engineering and construction problems. Although the area through which the canal extends is generally considered to be dry desert country, an average rainfall of 4 inches per year may be expected. These rains are not distributed throughout the year, but usually occur in infrequent heavy downpours during the spring or fall of each year. At periods of approximately 5 or 6 years apart, unusually heavy rains are experienced. The drainage area on the west side of the Chocolate and Orocopia Mountain slopes in a southwesterly direction, across the Coachella Canal line and toward the Salton Sea. Rains falling within this area collect in many steep channels and flow with great velocity on their course to the inland sea.

Run-Off Effect Observed

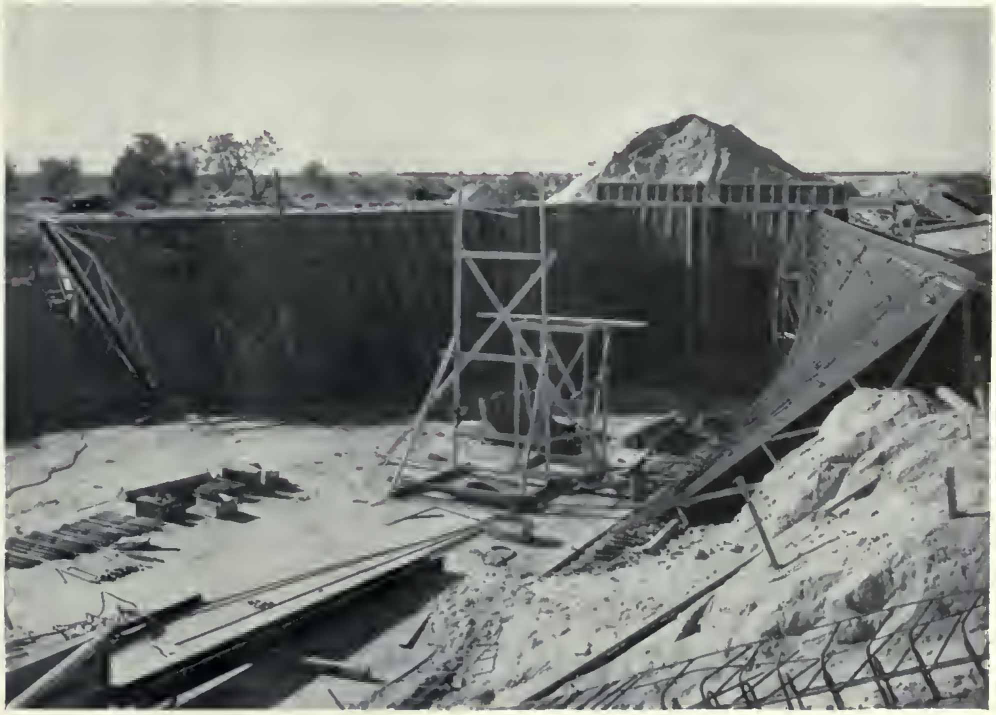
Bureau of Reclamation engineers were fortunate in being able to witness and study run-off effect in this area during a heavy rain which occurred in September 1939, and before actual construction of the wash crossing structures was started. This storm produced 4.08 inches of rain in a period of 24 hours. Information obtained in a study of the effect of this storm has aided materially in designing the structures and dikes for the protection of canal banks.

In order to protect the new canal against the destructive effect of floodwaters in the wash channels, 32 inverted siphons have been provided throughout this 40-mile reach of canal. These siphons are reinforced concrete structures of the double-barrelled, rectangular box type. The inside dimension of each box is 10 by 11 feet. Siphon lengths vary according to the estimated quantity of floodwaters that may be expected to pass through them. At each end of the siphons, reinforced concrete transitions occur, with sidewalls changing from the normal 2 : 1 slope of the adjacent earth section to the vertical walls of the siphon boxes. Natural gradients of wash channels have been maintained wherever practicable.

For protection of earth canal banks at siphon extremities, reinforced concrete wing walls have been constructed. Sloped paving extending from the base of these walls to below the wash grade is also provided to prevent undermining of the retaining walls, or of other portions of the structure.

Most of the wash siphons for this division of the canal are subject to very low hydrostatic pressure. One of the siphons, however, will be subject to a head of 54.8 feet. For this structure, a single circular type of barrel with a 14-foot 6-inch inside diameter will be used to provide greater strength than could

Use of prefabricated steel forms for transition wing walk on typical siphon crossing—Coachella Branch



be obtained in a rectangular type of box.

In addition to the 32 siphons there will be 4 automatic spillways. There will be 5 checks also in this division. Four of these checks will be integral with wash siphons. The spillways will be equipped with 10- by 6-foot top-seal electrically or automatically operated radial gates. Checks will be equipped with 10- by 12-foot electrically operated radial gates. Five wash inlets are also provided. These are reinforced concrete spillway structures and will serve as inlets to the canal for storm water, collecting on the upper side of the canal, that cannot economically be diverted into the main wash channels.

For economical construction, all rectangular siphon boxes have been made uniform in size. Transitions at the inlet and outlet ends also have been designed to uniform dimensions, except in the four cases in which check gates are to be installed at the inlet ends of the siphons. This standardization of barrel sections and transitions made the use of steel forms economically practicable, thus greatly facilitating construction and reducing costs.

Floodwaters cross Coachella Branch between head-walk at each end of box section

Although the canal is crossed by many wash channels, siphons are provided for only the larger ones, while diversion channels and dikes are constructed on the upper side of the canal to intercept the flows of intermediate washes and direct them to the main siphons. Approximately 39 miles of diversion dikes are required for the protection of canal banks along the second division.

Owing to the steep natural gradients of the wash channels, and the consequent high run-off velocity, it is necessary to protect the diversion dikes with heavy blankets of riprap at points where they intercept the washes. One of the construction problems faced during the progress of this work is that of obtaining sufficient quantities of satisfactory rock to be used as riprap. The only deposit of suitable material that has been found in the vicinity is located 2 miles from the main canal line, and opposite a point which is approximately midway between the ends of the work. Thus, the maximum haul for riprap material is about 22 miles.

Sand and gravel to be used in the manufacture of concrete for structures on the Coachella Branch Canal have been obtained from a deposit located on what is known as the "Old Beach Line," or the shore line, of an ancient lake.

In order to transport material, supplies, and equipment to the various structure sites, it has been necessary to construct a surfaced operating road parallel to the canal throughout the entire 40-mile length of the division. Although the work has not been carried on simultaneously on all of the structures included in this section of the canal, it has been started on 15 of the structures which are distributed over a distance of approximately 16 miles. In some instances, work has progressed on as many as 8 of these structures at one time.

In order to carry on this amount of work with a minimum outlay for equipment, each piece has been made as mobile as possible. For this purpose, all of the smaller pieces such as compressors, lighting plants, butane gas tanks, and pumps are mounted on pneumatic-tired chassis.

Three 1-yard pavers are used in mixing concrete. A 50-ton rubber-tired trailer, which is towed by 1 or 2 motor-patrol road-graders, is used for transporting the mixers between structure sites. Concrete aggregates are dry-batched at a central batching plant located at the sand and gravel pit and are then hauled to the mixers in batch trucks. The beds of these trucks are divided into 4 compartments, each of which has sufficient capacity for the aggregates required in a 5½-sack, or 1-yard concrete batch. On the longer hauls, as many as 10 trucks are used at one time to transport aggregates to the mixers.

It has been necessary to transport water for construction purposes by pipe line from the nearest irrigation lateral, a distance of 7,500 feet from the canal line. Water is discharged into storage tanks or natural reservoirs, and from these reservoirs pumped through another pipe line, parallel to the canal, to the various structure sites. A total of 58,000 feet of 4-inch pipe is required to carry water from the irrigation lateral to the most distant structure site.

Because of the high air temperatures that prevail in this area during the summer months, the concrete placing season on Bureau of Reclamation work is limited to the months of October to May, inclusive. Even during that period, special precautions are sometimes taken to keep concrete temperatures below 90° F. During the months of April and May 1940 it was especially difficult to maintain concrete temperatures below 90° F. This was mainly on account of the heat that would be absorbed by mixing water in transit along exposed pipe lines. These lines are laid on the surface of the ground and are subjected to the direct rays of the sun throughout their entire length. In early April it became necessary to place concrete during the night, in order to take advantage of the cooler air, but in order to be able to place concrete in daylight hours also, a water cooling tower was constructed which proved to be very effective in lowering the temperature of the water from the pipe line and thus maintaining lower concrete temperatures in daytime placement periods.

In addition to the building of diversion channels and concrete structures, work in progress also includes excavation of approximately 40 miles of earth canal. The canal through this section varies in bottom width from 46 feet at the upper end to 40 feet at the lower end. In many places along the main canal, a type of material is being encountered that very closely resembles beach sand, consisting of fine particles of sand of uniform size. Where this material is encountered, it is necessary to excavate the canal beyond designed limits to permit future construction of a clay lining if it is later considered desirable.

It is anticipated that concrete work will be completed in the fall of 1941. At the present rate of progress, it is estimated that canal excavation under the contract will be completed by the end of 1942.

Excavation for Parker Dam Power Plant

By TOM R. JOHNSON, *Associate Engineer*

EXCAVATION for the Parker Dam power plant lays no claim to the superlatives applied to many present-day jobs. The yardage removed was not the largest, neither were conditions the toughest, but to keep costs under an extremely low bid called for plenty of efficiency, ingenuity, and plain hard work.

For $276,000 Clyde W. Wood of Los Angeles agreed to remove the top of two small mountains amounting to 332,000 cubic yards of solid rock for $0.48 per cubic yard, excavate 13,500 cubic yards of 27-foot diameter tunnel, also solid rock, for $5.90 per cubic yard, and finally complete powerhouse foundation excavation of 6,000 cubic yards of $2 rock. In addition his contract called for him to furnish and erect 280,000 pounds of tunnel lining at $0.09 per pound.

Parker Dam is located on the Colorado River 50 miles downstream from Needles, Calif. The dam was completed by the Bureau of Reclamation in 1938. The powerhouse river wall was built to an elevation above tailwater level at that time to take advantage of the same cofferdams used in the construction of the dam. This allowed subsequent final construction of the powerhouse in the dry at some future date, possibly 1950. However, power demand, particularly in the Salt River Valley, Ariz., exceeded all expectation with the result that contracts were made necessitating construction of the project at this time. These contracts were between the United States, the Metropolitan Water District of Southern California, the Salt River Valley Water Users' Association operating the Salt River project, Arizona, and the Central Arizona Light & Power Co. of Phoenix, Ariz. In general, these contracts provide for the immediate construction of the Parker Power Plant and transmission lines from Parker Dam to Phoenix and to Blaisdell (near Yuma), Ariz. Provisions were made in these contracts for immediate transmission of Boulder Dam power over the Metropolitan Power District lines to Parker Dam, thence over the new Bureau of Reclamation line to Phoenix. This hook-up will be discontinued when the Parker Power Plant goes into operation. Power will be supplied to the Salt River Valley Water Users' Association and to the Central Arizona Light & Power Co. Each will be entitled to receive 30,000 kilovolt-amperes for 20 years and each will make a minimum annual payment of $220,000. Power will also be furnished the United States Indian Service at Parker, Ariz., and to the Gila project near Yuma, Ariz. Revenue derived from the sale of power will be used to repay the cost of the Parker Dam power project.

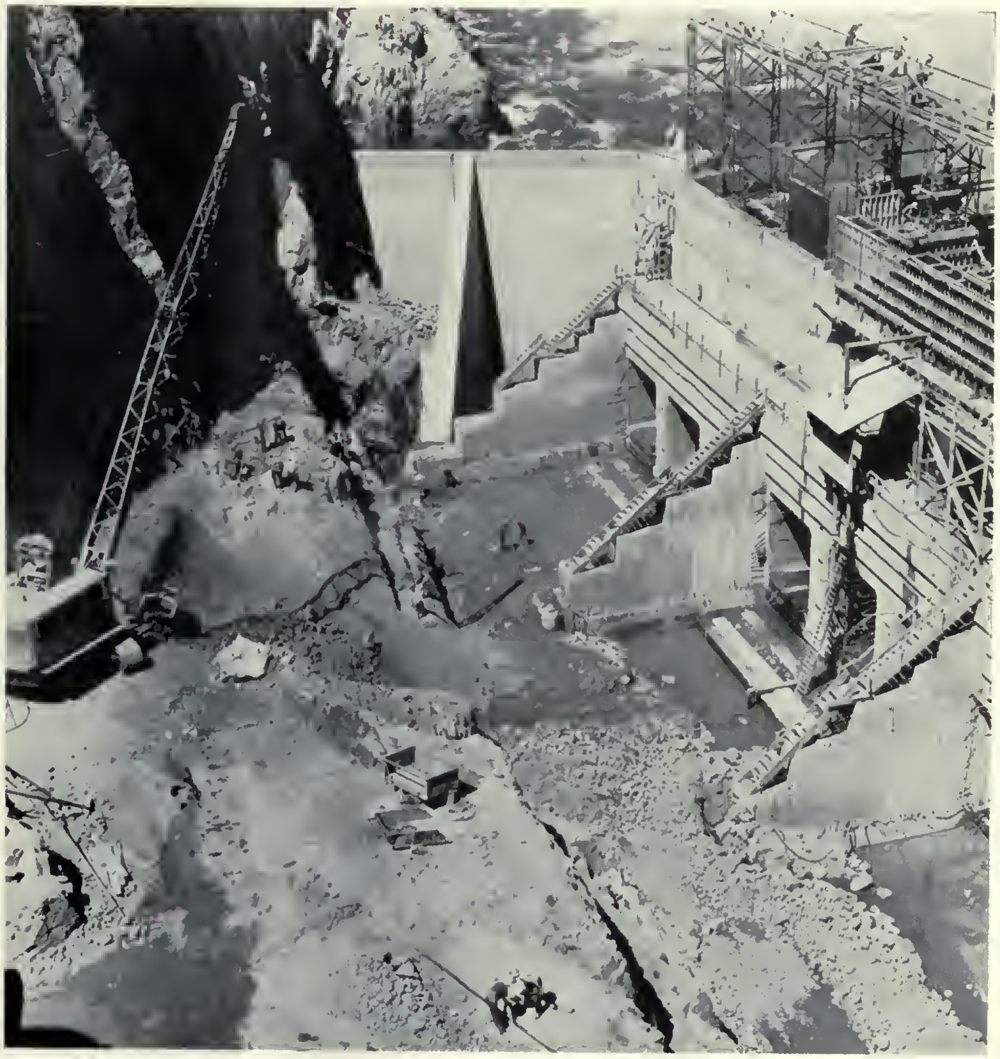
Clyde W. Wood was given notice to proceed on November 21, 1939, and Government forces began construction of the powerhouse as rapidly as excavation progress permitted in an effort to complete three 40,000-horsepower generating units in the shortest possible time.

As will be seen on the accompanying drawing, the upstream edge of the powerhouse is only a short distance downstream from the right abutment of the dam. The dimensions of the powerhouse are roughly 130 by 300 feet. The forebay as excavated originally extended from the trashrack structure to line X–X. The contract just completed had extended the forebay approximately 80 feet downstream and removed the top of the hill as indicated in section A–A. Four tunnels through the remaining portion of the hill connect the powerhouse and forebay areas. The switchyard area, excavated under Clyde W. Wood's contract, begins at a point near the forebay and extends 643 feet downstream, parallel with the river.

Penstock Tunnels

Four penstock tunnels, built on a slope of 23 feet per hundred, connect the inlet portal face of the forebay with the powerhouse. The tunnels approach the turbine unit centerline obliquely, resulting in varying lengths of 140 to 177 feet. All four tunnels are nearly parallel and all have a slight curvature in an inclined plane. The upstream 103 feet is on a 23

Powerhouse area from downstream. One of the penstock tunnels is visible just above the dragline excavator



percent grade but becomes level at the downstream end after passing through the inclined curve. The upstream end of each tunnel is flared to form an elliptical opening of 27-foot width and 40-foot height to the regular 27-foot diameter section in a distance of 40 feet.

Excavation of the tunnels was begun from the downstream end. The portals of the three tunnels farthest downstream presented no particular difficulty in development. Short rounds of few holes and light loading were used until a vertical face of full 27-foot diameter was exposed. This work was done by jackhammer drilling from improvised scaffolding or muck piles. The farthest downstream tunnel required roof support to get underground but aside from this, all these tunnels were driven through their entire length without ribs or lagging. Tunnel 1, farthest upstream, entered a rock face at such an angle that no roof arching was effective for the first 25 feet. This necessitated a squaring-up of the face as well as the installing of structural rings and lagging for 9 feet before the rock was deemed to be safe.

As soon as portal development permitted, use was made of an ingenious type of jumbo perfected by Clyde W. Wood. Adapted for full circular heading drilling, this jumbo consisted of two structural rings 19 feet in diameter, separated by pipe rungs and mounted on a two-wheel carriage. The rings in conjunction with three radial pipe arms that served as drifter mounts, made up a unit that could be tipped back and forth on a transverse axle and raised or lowered by hydraulic jacks. Power for tipping was provided by a tractor hoist through blocks and falls attached to the top of the ring assembly.

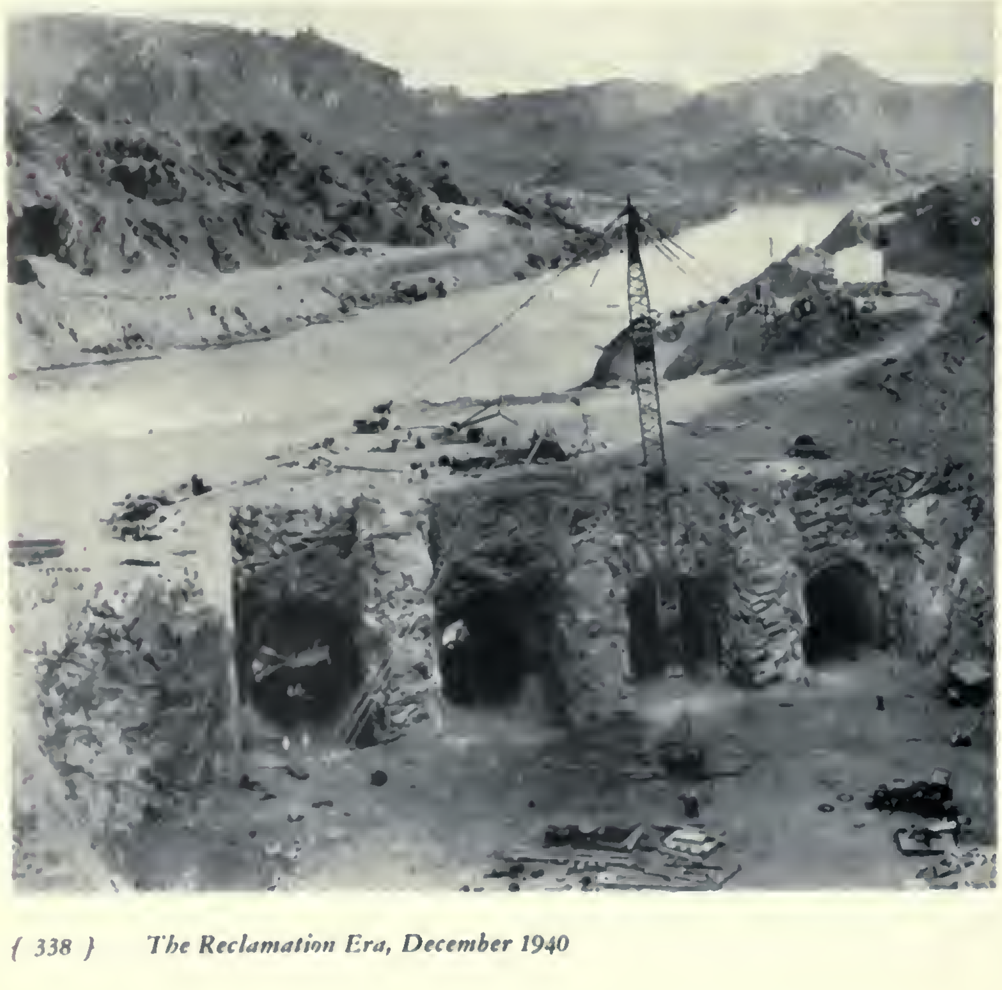
The jumbo was pushed into position by an RD-8 caterpillar tractor, the ring assembly raised to the proper elevation by hydraulic jacks and tipped to the right inclination by the blocks and falls.

Two 4-inch drifters were mounted on each of the three radial arms which could be rotated by hand-operated chain hoists. Clamps on the radial arms allowed fixing the drifters at any required distance from the center.

Using this jumbo with a complement of 5 drillers, 5 chuck tenders, 2 nippers, and a foreman, a full heading could be drilled and shot in less than an 8-hour shift. The drifters averaged 13 feet per hour, total time, which included loading time of approximately 16 percent. Eight-foot rounds were drilled in all tunnels except the one nearest the dam; here rounds were limited to 6 feet by reason of the proximity of the dam abutment.

A typical heading consisted of 6 cut holes, 14 relievers, 18 holes distributed uniformly along a 11½-foot radius, and 36 along the outer periphery.

Inlets to four 27-foot diameter penstock tunnels. Flared transitions at the upstream end of each tunnel result in an opening 27 feet wide by 40 feet high



By use of the 0 to 10 delays, the holes were fired in groups progressively from the center, not exceeding 11 holes in one delay. The weight of 40 percent gelatine dynamite was limited to not more than 50 pounds per delay and was generally less. Eight-foot rounds pulled an average of between 6 and 7 feet of ground, 6-foot rounds about 4½. One and nine-tenths pounds of dynamite were required per cubic yard of rock removed.

Muck from the tunnels was loaded by the 1½-cubic yard Lorain shovel previously employed on the open cut work. It was adapted to tunnel use by shortening the boom and stick, removing a portion of the after carriage, and substituting a 50 horsepower electric motor for the gasoline engine. The shovel loaded directly into the 6-cubic yard White and Hug trucks; this facilitated by cutting off a portion of the high sides of the truck bodies used in the open cut work.

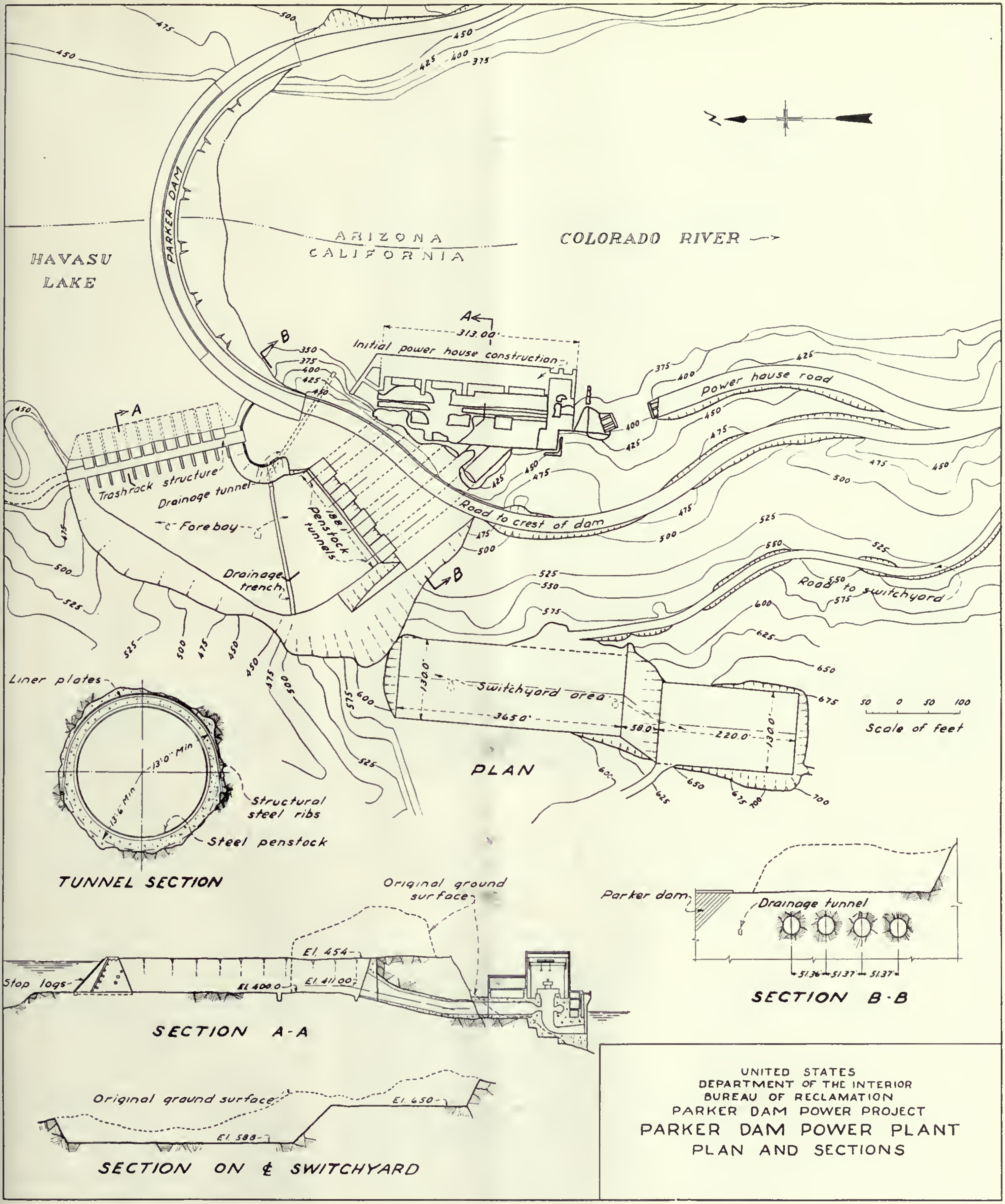
The upstream flare of the tunnel was formed by increasing the roof grade, the floor grade remaining unchanged. The circular jumbo frame was not adaptable to drilling full heading of increased height in the flared section. Therefore, the tunnels were holed through as a circular section on the floor grade and then, with the jumbo reversed in direction and elevated by cribbing placed on muck, a single long round (12 feet) removed the bulk of the roof rock. Tight rock between the end of this round and the normal section was stoped from a timber frame jumbo built on a Moreland truck.

Tunnel Roof Support

It should be emphasized that care exercised by the contractor in hole spacing, loading, and shooting was mainly responsible for the rock holding up well during and after the tunneling process. Less care certainly would have resulted in overbreak, ragged, unsound faces, and added support difficulties.

A contact zone cuts through the downstream portion of all tunnels with a dip of approximately 16 degrees. Above this contact the rock is fairly firm and sound, but appreciably altered, granitic rock. It is of reddish-brown color, closely jointed in all directions, and without any regular pattern. Below the contact the rock is similar except that alteration is more pronounced, with closer, irregular jointing. Scattered parts of the mass have a tendency to crumble. The contact zone is about 12 inches thick and is associated with the underlying rock.

The rock, however, was subject to air-slacking over relatively short periods of time. Placing of the steel penstock tunnel lining and subsequent concreting being possibly a year distant required tunnel support against such falling rock as air-slacking might engender. To such end roof liner plates were erected 7 feet right and left of the centerline. These one-fourth-inch thick, 2 feet wide and 3 feet long steel plates rested on 6-inch I-beams at



UNITED STATES
DEPARTMENT OF THE INTERIOR
BUREAU OF RECLAMATION
PARKER DAM POWER PROJECT

PARKER DAM POWER PLANT
PLAN AND SECTIONS

17.25 pounds rolled to a circular section of 13-foot neat inside radius. The structural rings were placed on 3-foot .5-inch centers and were tangential 1 foot 8 inches above springing line to a concrete wall plate 3 feet 4 inches below springing line.

All tight rock trimming was performed as each structural ring was erected, the preceding ring acting as a guide. Liner plates 2, 5, and 7 right and left of centerline were welded to the structural rings, the others being bolted so as to facilitate removal immediately prior to concreting. Timber stulls were installed between the roof and the structural rings adjacent to the welded plates. All ring and liner plate erection was done from a timber frame jumbo erected on a Moreland truck.

The method of tunnel driving used by Clyde W. Wood developed a section of minimum overbreak in the shortest possible time. No major accidents occurred during the driving, although in placing the liner steel one workman suffered a serious but not permanently damaging fall.

Forebay

Excavation of the forebay may be divided into three main steps. The first stage consisted of removing the hill above the level of the roadway at the crest of the dam. This involved cuts ranging up to 180 feet. The contractor started at the top and took off successive 18-foot layers of rock until roadway level was reached. Rock slopes were generally trimmed as excavation progressed. The second step in forebay excavation involved all rough excavation between the level of the roadway at the crest of the dam and the floor of the forebay—a vertical distance of 55 feet. As this material had to be hauled out of the forebay area, a steep ramp was built along one side. The final and third stage consisted of the removal of the ramp and also the final trimming of side slopes below the level of the roadway at the crest of the dam. Since concrete is to be placed against most of the rock surfaces in this part of the forebay, close adherence to neat lines was desired. All muck removed during this final work was hauled out through the tunnels. The rock in the forebay area was of uniform hardness which developed muck of regular size, tending toward easy shovel loading and bulldozer manipulation.

As the excavation of the forebay was close to the dam, special tests were made to be sure that the shock created by blasting would not injure the completed concrete structure.

For the purpose of blasting control the forebay was arbitrarily divided into four areas. Maximum limits of weight of 40 percent dynamite per delay were assigned to each area depending on the proximity of the area to the dam abutment. Limits of 75, 100, 150, and 200 pounds were set for corresponding minimum distances of 90, 160, 210, and 260 feet. The 75-pound limit was reduced to 50 below the level of the dam crest.

Switchyard

The switchyard covers a large area broken into two benches. The lower, upstream bench is 130 feet wide and 365 feet long. The downstream bench is the same width and 220 feet in length. The downstream bench is 62 feet higher and a 1 to 1 slope connects the two.

The contour of the original ground was rugged with indicated cuts exceeding 80 feet to grade. The lowest point was a saddle in the center of the lower bench. To this point the contractor constructed a temporary side hill service road. From the saddle, excavation was directed both upstream and downstream by jackhammers followed by wagon drills. One wagon drill was mounted on the front end of a 75-horsepower caterpillar tractor and was suited, as were the jackhammers, to the rugged terrain. Wagon drills of the conventional type followed after initial leveling rounds.

At the downstream end of the lower bench the rock along centerline rose almost 60 feet. A ramp constructed on one side of this rise allowed access to the higher bench.

Depth of round was limited by the 18-foot length of available wagon drill steel until final grade was approached. Holes of this depth were drilled on 10-foot centers, chambered and, generally speaking, fired on nodelays. No restriction as far as amount of explosive or pattern of delaying was imposed on the contractor except at the extreme upstream end. Here owing to the proximity of the right abutment of the dam, a limit of 250 pounds of 40 percent dynamite to one delay was established.

The muck resulting was generally disappointing from the viewpoint of the contractor. The rock in the switchyard area consisted of huge plums of hard, dense granite surrounded by rock sufficiently altered as to make it relatively soft. The force of the explosive sought out the weaker zones encasing the harder with the result that many large "donickers" defied both bulldozer and 2-cubic yard shovel. Plugging of these boulders proved to be a regular and expensive operation.

Forty percent nitroglycerine base bag powder was the general rule in the open cut work although some 20 percent was used. Slightly over five-eights pounds of powder was required per cubic yard of rock.

Powerhouse Foundation

Clyde W. Wood's original contract called for the removal of 6,000 cubic yards of rock excavation in the powerhouse area. The purpose of this excavation was to develop trenches for the penstocks adjacent to the downstream tunnel portal. Several benches developed at and above elevation 361 also contributed to this yardage. No unusual features were encountered in this excavation. Muck was hauled away from the area on a temporary ramp over the downstream powerhouse river wall.

A supplemental contract was made with the contractor to remove an additional 4,000 cubic yards of rock in the powerhouse area to an elevation 32 feet lower than originally contemplated. The purpose of this excavation was to develop additional longitudinal benches, an intermediate bench at elevation 345 and the lowest at 329. The intermediate bench being only 7 feet wide did not permit proper access of excavation equipment inasmuch as these benches were bounded at the ends by the powerhouse river wall.

As a solution to a difficult muck-handling problem the rock was blasted and allowed to fall or was hand-mucked to the lowest bench. Here it was consolidated by a caterpillar tractor at the junction of a small natural ravine connecting the highest and lowest benches. The dragline situated on the highest bench had no difficulty in withdrawing the muck up the ravine.

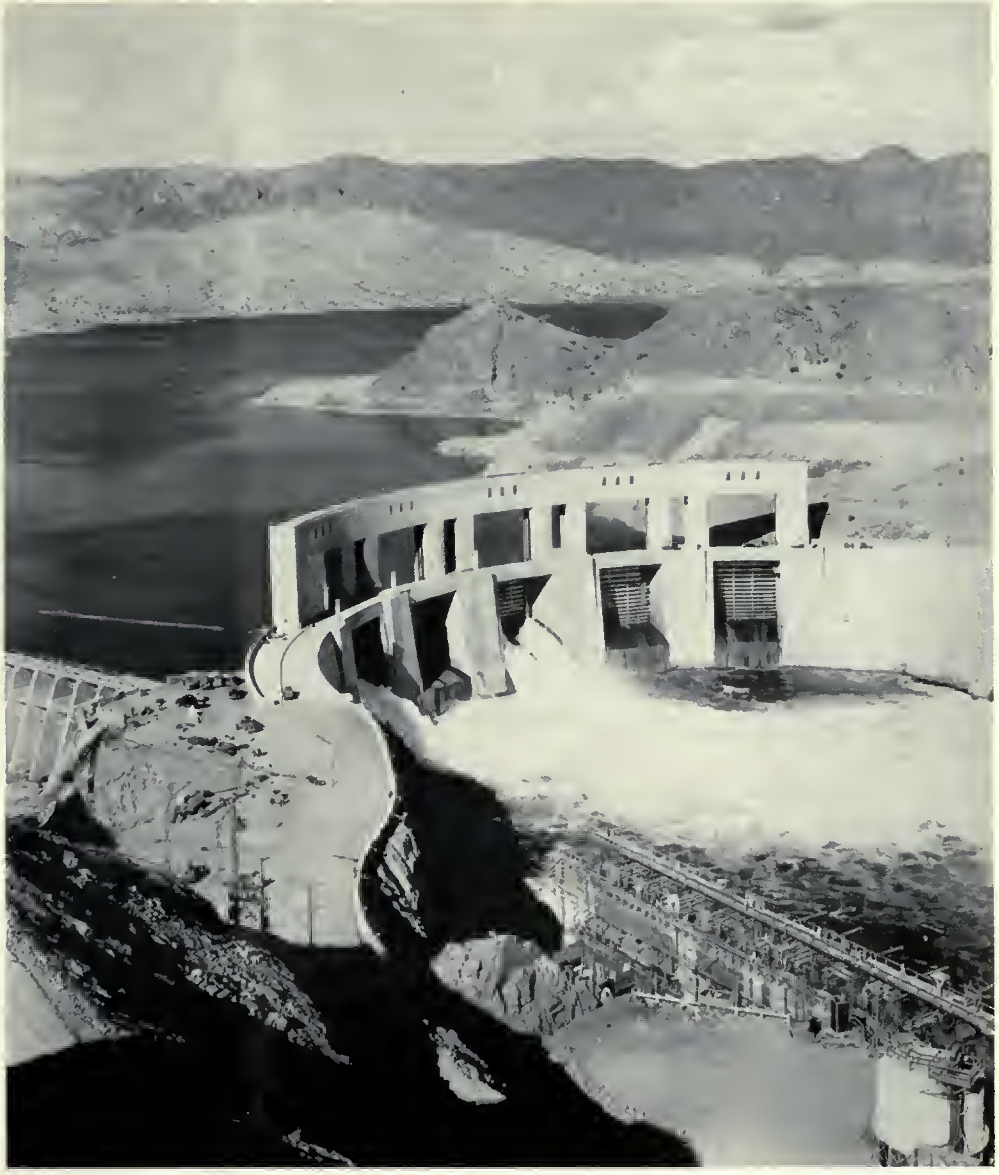
Subsequent concreting in the ravine area prior to completion of excavation in the downstream portion of the powerhouse led to a variation of the method outlined. Sufficient muck was allowed to accumulate on the lowest bench to allow the 1½-cubic yard Lorain shovel to be ramped down. From here muck was shoveled directly into the dragline bucket. Upon completion the shovel was removed by means of a timber ramp.

The Parker Dam Power Project

THE accompanying picture portrays the change that is taking place at Parker Dam on the Colorado River. Parker Dam was completed in the summer of 1938. At that time the demand for power development was considered to be 15 or 20 years in the future and as a consequence the only concession to power was in the form of a concrete wall immediately below the dam which was to function as a cofferdam during the later construction and was also to become part of the powerhouse substructure.

Although it was originally planned to furnish power to the area around Phoenix, Ariz., no immediate demand was anticipated. However, a water shortage in the Salt River Valley reducing water power generation made it desirable that Parker power installations be expedited to the maximum and transmission lines constructed from the power plant to Phoenix as soon as possible. Since the lines would be completed long before power could be made available from Parker, a special arrangement between the Metropolitan Water District of Southern California and the Salt River Valley Water Users' Association was made whereby the association would be supplied Boulder Dam power over the district's line to Parker. The necessary contracts were negotiated in late 1938 only a few months after the dam was completed. Surveys were begun

Parker Dam power plant being constructed in foreground



in early 1939 and transmission line construction to Phoenix swiftly followed. The Phoenix area has been supplied with power from Boulder Dam at the continuous rate of 20,000 horsepower since January 1940.

The power project consists of a large powerhouse on the California side of the Colorado River just below Parker Dam. Provision has been made for four 40,000 horsepower units with the necessary transformers and switching facilities. Transmission lines from Parker Dam to Phoenix, 140 miles, and from Parker Dam to the Gila project, 120 miles, were completed in early 1940. Transmission lines proposed extend from Phoenix to Sacaton, 50 miles; Phoenix to Tucson, 125 miles; and from the Gila project to Drop No. 4 in the Imperial Valley, a distance of about 50 miles. A large substation with synchronous condenser equipment is proposed for Phoenix and substations are to be constructed also at Tucson, on the Gila project and at Drop No. 4. The total estimated cost of the project is $14,860,000.

The main part of the construction work at Parker Dam is being done by Government forces. Excavation of the forebay and tunnels and the fabrication and installation of the penstocks are by contract. Excavation is now nearing completion.

Philip A. Rosendorn on Federal Board of Surveys and Maps

Philip A. Rosendorn, chief draftsman of the Bureau of Reclamation, has been designated representative of the Bureau on the Federal Board of Surveys and Maps, vice Walter I. Swanton, retired.

Commercial Gladiolus in the Yakima Valley

By J. T. ROBERTSON, *President, Washington Gladiolus Society*

A VERY large percentage of the gladiolus bulbs grown commercially in the United States for many years has been grown in the West, particularly around Grants Pass, Oreg., and throughout the Willamette Valley and in the Puget Sound area.

Much of the soil in a certain region has become foul as one result of this continued growing, and planters have begun looking for new localities because many of their eastern customers to whom bulbs have been and still are shipped in car lots are becoming skeptical as to the quality of the bulbs grown under existing conditions. Some of these growers have already moved to new locations and it has been the hope of the writer to interest them in the possibilities of the Yakima Valley, where bulbs can be grown as advantageously as in any other locality.

J. T. Robertson in his screened-in bulb-drying shed

The Yakima Valley has to offer: (1) Ground that is free from any gladiolus diseases, and being largely virgin soil so far as gladiolus culture is concerned, is in such shape that the grower will dig stock true to name, which is not the case where plantings have been made over several years; and (2) a long season which enables growers to plant early and allows ample time in the fall to dig and thoroughly cure the bulbs.

The writer has had several recent let-

J. T. Robertson, president, Washington Gladiolus Society, and crew digging and screening gladiolus bulbs on one of his tracts near Sunnyside

ters from eastern commercial growers complaining of the poor results from some of the districts above referred to, which they attributed to disease-laden soil, and one grower in the Puget Sound area has stated that he has been tempted, after digging in the fall, to ship his bulbs here to be cured.

Growers on a large scale, as many of these growers are, have a very heavy investment in their present locations with all the permanent equipment necessary to handle the bulbs, and, as moving is quite a consideration, this probably explains why we have not had any real response to the invitations sent out to "come and see for yourself."

For some years we have worked to the end that we might have the Washington (State) Gladiolus Society put on its annual show in the Yakima Valley, but until this year the executive board of that group, consisting for the most part of commercial growers west of the Cascades, was not particularly interested in our proposal, and there are probably legitimate reasons why those who generally put on large displays at the show should object because of transportation of their bloom. This year, as a result of the election of the writer to the presidency of the society, D. N. Wood of Sunnyside to the secretaryship, and G. Hilton of Zillah to the vice presidency of the Eastern Division, we had a majority on the board and the westerners capitulated to us. The entire financial burden was borne by Sunnyside, which put on an excellent show, attracting large crowds from all sections of the State and from other States.

The prime object of any such show is to educate the visiting public in gladiolus and to stimulate interest in home planting which naturally increases the sales of bulbs, the commercial growers' business. Behind our show was the idea that we could expect a number of commercial growers from different sections who might see the possibilities of our valley and in this we were not disappointed; in fact, the displays put on by the commercial growers exceeded our expectations. Many of those present were nonexhibitors and some of them helped in the judging. We had growers from Tacoma, Pacific, Bothell, Everett, Lowell, and other points in the Puget Sound area, also one, Milton Jack, from Hatzic, B. C. The nonexhibitors were, for the most part, from different sections in Oregon, and all left very favorably impressed with our community and valley and with memories that at some future time might lure them to the Yakima Valley as a good place to locate and to continue the commercial growing of gladiolus bulbs.

Some of the commercial growers, in addition to planting for bulbs, cultivate for the cut-flower trade, and this applies to those near such centers as Portland, Seattle, Tacoma, Everett, and Bellingham. As a general rule these growers cannot figure on cutting much, if any, bloom until well into July. In the Yakima Valley—and no doubt this will be more apparent on lands coming under the Roza division, where it is a little more frost-free and, if anything, somewhat earlier—we can beat this by at least a month and, if given a very early season, by about 6 weeks, which would mean a much better price for the bloom shipped. An early season occurred in 1934 and the writer started cutting bloom on June 5. Shipping facilities from the valley are such that bloom cut in the evening would reach Seattle, Tacoma, Portland, Everett, or Spokane early the next morning, almost as soon as it could be delivered from the present growing centers adjacent to the cities named.

Gladiolus growing, as the writer sees it, would be one more crop for our already well-diversified valley and should be as profitable to the commercial grower here as in any other section of the West. The quality of bulbs produced also would be the equal of those grown in any other locality; in fact, with conditions such as to enable the grower to thoroughly mature and cure the bulbs, they might even be superior to those grown in most other sections.

Essential Features of the Bureau's Fish Hatchery at Leavenworth, Wash.

By S. E. HUTTON, *Assistant Director of Information*

AN institution, which Supervising Engineer Frank Banks calls the Bureau's fish college, is in operation at Leavenworth, Wash., for the salmon and steelhead classes of 1940–41. Its purpose is to teach future generations of the tribes of migratory fish that formerly spawned above the Grand Coulee Dam to perform that function hereafter in tributaries of the Columbia River below the dam, because that huge structure makes it impossible for the matured fish to reach the upper tributaries, and would offer a fatal hazard to the downward migration of the resulting offspring.

Since the salmon, the important commercial fish to be considered, returns, usually at the age of 4 years, to spawn in the shallows of the stream in which it spent its early free life before migrating to the sea, the offspring of fish which were native to streams above the Grand Coulee Dam must be planted in tributaries lower down, so as to establish there the spawning grounds for themselves and their descendants. This involves the operating of traps in the Columbia River at the Rock Island Dam, 150 miles downstream from the Grand Coulee Dam, and of a large plant at Leavenworth, to which adult fish, bound upstream to spawn, are hauled in tank trucks.

The essential features of the plant at Leavenworth are holding ponds, in which the fish reside until they ripen for spawning; a hatchery wherein eggs are placed in troughs and hatched; rearing ponds, in which young fish are bred to various ages before being released, in order to reduce the mortality rate, naturally incident to the release of freshly hatched fry; and facilities for furnishing water to the plant in required quantities and at proper temperatures.

The holding ponds have been formed in the channel of Icicle Creek, about 2 miles south of Leavenworth, Wash., by building four dams across it. The uppermost of the four, known as Dam No. 2, regulates the flow of Icicle Creek through the ponds, and diverts any excess water through a canal 4,085 feet long to a point in the creek channel below Dam No. 5. Each holding pond contains a deep and a shallow section, the former for the salmon to rest in prior to spawning and the latter where they can be readily captured by seine net when they move into shallow water to commence spawning.

Buildings

The hatchery plant, located on the left bank of Icicle Creek just below the holding ponds, includes in its group of three main buildings a hatchery building with a hatching room 88 feet wide and 225 feet long. Two two-story wings, 36 by 45 feet in plan, provide space for office, laboratory, storage rooms, recreational space for employees, and reception and rest rooms for visitors. A combined shop, garage, and warehouse building, one story high and 142 feet 8 inches long by 89 feet 8 inches wide; and a third building, 67 feet 8 inches by 96 feet 8 inches in area, to house central-heating equipment, refrigeration apparatus, food-grinding machinery, and cold-storage rooms, complete the building group.

Adjacent to the hatchery building are two groups of rearing ponds, one containing 30 ponds 30 feet wide and 130 feet long, and the other 40 ponds 18 feet wide and 76 feet long.

The water supply for the plant is derived from Icicle Creek and the Wenatchee River, and will be supplemented at certain times, particularly in winter, with water from wells. Ordinarily, the minimum flow of 100 cubic feet per second through the holding ponds will be taken from Icicle Creek, through Dam No. 2, but it will be possible to admit, through this dam, additional water from the Wenatchee River.

Dam No. 2 serves to divide the flow of Icicle Creek between the holding ponds, formed in the creek channel, and the diversion canal, which begins above the dam and ends in a junction with the creek channel below Dam No. 5. Dam No. 2 was built across the channel of Icicle Creek. It is a reinforced concrete structure, roughly 20 feet high, exclusive of cut-off walls, 38 feet long, up and down stream, and about 36 feet wide. Water is admitted to the holding ponds through two openings in the concrete, 16 feet wide and 5 feet high, at the bottom of the channel, each opening controlled by a radial gate. The water level above the dam may vary from elevation 1,124 to 1,140. Below the dam, in the upper holding pool, it will be, normally, about elevation 1,123.

Below Dam No. 2, the flow broadens from 34 to 143 feet, and issues through a diffusion structure into the upper spawning bed. The diffusion structure is a weir so arranged that water flowing through it is directed downward into a pit, from which it rises through a diffusion grating into the next pool. If the water fell from one pool into the next, the fish would damage and exhaust themselves in fruitless attempts to scale the weirs.

Below this diffusion structure is a spawning bed about 135 feet wide and 197 feet long, the bottom covered with pit-run gravel and sloping 6 inches in its length. In the lower left-hand corner of the bed is a seine-landing platform, 81½ feet long and 25 feet wide, in front of a spawning shed, 32 feet wide and 36 feet long.

An 11-foot flume extends along the left side of the spawning bed, from the rack at its lower end through a trap entrance at the diffusion structure. About midway of its length is an elevator, by means of which steel-heads, after spawning, can be loaded into tank trucks for distribution to streams, since they do not end their life cycles with spawning as do the Blueback and Chinook salmon. Roads are provided for access to all structures.

Dams 3, 4, and 5 are similar in design to the diffusion structure below Dam No. 2, and they serve the same purpose; but, in addition, they also maintain, by means of stop logs, the 3- or 4-foot differences in the water levels between successive pools.

Diversion Canal

The Icicle Creek diversion canal or wasteway is 115 feet wide on the bottom, with slides sloping 2 to 1. The bottom and left bank were covered with a 12-inch layer of coarse gravel, and the right bank, along the creek, was riprapped with rock taken from excavations. The canal is 17.45 feet deep, and, with a water depth of 14.45 feet, will carry 10,000 cubic feet per second, twice the maximum recorded flow of Icicle Creek.

The diversion canal drops only about a foot in its 4,085-foot length, leaving a difference of 10 to 12 feet between the bottom of the canal and the water level in Icicle Creek below Dam No. 5. Connection between the diversion canal and the creek channel is made through a concrete outlet structure 210 feet long. In the upper 40 feet of the structure, wing walls reduce the width of the channel to 100 feet, and an apron slopes up from the canal bottom at elevation 1,124.65 to a crest at elevation 1,129. From that point, the channel is reduced to 80 feet in width, and falls 22 feet in elevation in 130 feet, to a second apron 40 feet wide and provided with dentated sills to reduce the velocity of water discharged into Icicle Creek. A steel highway bridge spans the outlet structure at its lower end.

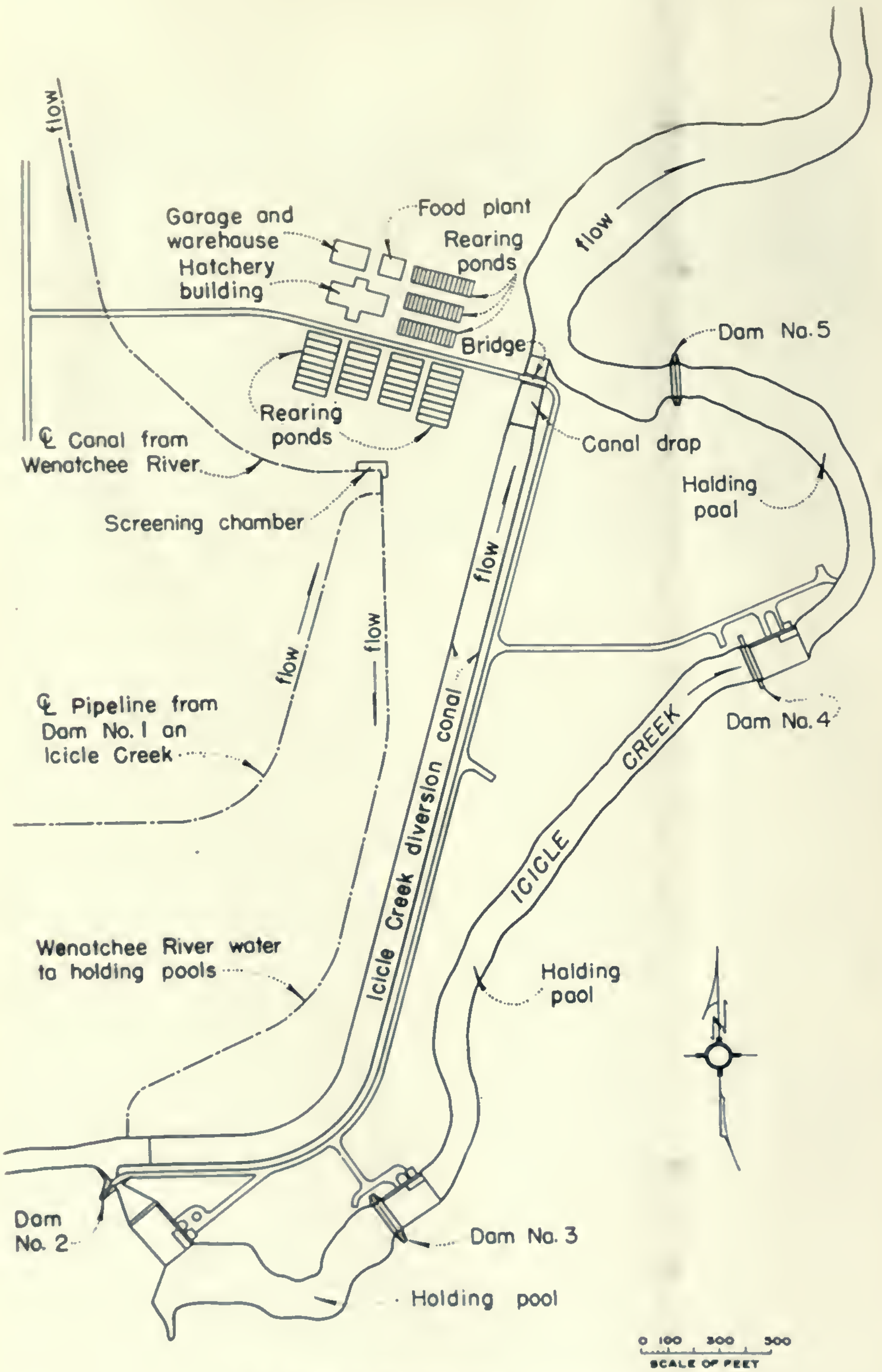
Water for the hatchery and rearing ponds is available from Dam No. 1 in Icicle Creek, three-quarters of a mile upstream from Dam No. 2, through a 6,635-foot pipeline, and from the Wenatchee River through a 16,000-foot canal. The pipeline and canal meet at screening chambers near the hatchery. There, entrained debris is removed, and the water can be mixed in any ratios necessary for temperature control. A system of pipes extends from the screening chambers to the hatchery and rearing ponds, and an extension of the Wenatchee Canal bypasses the screening chamber and intersects the Icicle Creek diversion canal near Dam No. 2. At that point, the bottom of the canal is low, so that water from the Wenatchee River can supplement the Icicle flow through Dam No. 2 in case it alone is insufficient for the fish in the holding ponds.

The handling of the water supply to the plant is governed by the requirements for keeping the adult fish in healthy condition and for controlling the hatching time, and by the flows and temperatures of the three water sources.

Although salmon, in their migration from the sea to spawning grounds, can safely spend short periods in relatively warm water (75° F. to 80° F.), they are accustomed to and remain healthy only in cool water. In the holding ponds, where adult fish may be held several months while ripening, the temperature range cannot be great, and temperatures cannot be high if heavy mortality is to be avoided. Ideal conditions would be realized if, in the holding ponds, there could be duplicated the conditions that exist in deep pools near the sources of streams, where the fish await the spawning season. Experiments have shown that water temperatures up to 62° F. are satisfactory in holding ponds, but that temperatures above 65°, if long sustained, are dangerous.

Hatching time varies with temperature, and can be controlled quite closely, higher temperatures shortening the incubation period. Preferred hatchery temperatures range from 39° to 52° F. In rearing ponds, water temperatures between 52° and 65° F. give satisfactory results.

The water supply from Icicle Creek varies



LEAVENWORTH STATION
MIGRATORY FISH CONTROL
COLUMBIA BASIN PROJECT

in temperature from 32° in winter to 63° in late summer, and that from the Wenatchee River from 38° or 40° in spring and fall to 70° in summer. The well water temperature is practically uniform at 50°.

A flow of 160 second-feet is available from the Wenatchee River, 6 second-feet from wells, and 20 second-feet or more from Icicle Creek, except after about July 20, when the unappropriated natural flow diminishes rapidly. Then the flow of Icicle Creek will be augmented, and the water temperature will be reduced by drawing cold water from the depths of Snow Lake through a 2,500-foot tunnel, which taps it about 150 feet below its normal surface.

Ordinarily, the holding pools will be supplied with 100 second-feet of water from Icicle Creek, any excess being diverted by canal, around the holding ponds. When the unappropriated flow of the creek is inadequate and temperatures are not too high in the Wenatchee River, supplemental water from that stream will be furnished to the holding pools. If the temperature in the Wenatchee River is too high, cold water will be drawn from Snow Lake into Icicle Creek, water from the three sources being mixed to maintain a temperature not above 65°, and to conserve the Snow Lake storage.

Normally, the water from Icicle Creek and the Wenatchee River will be of satisfactory temperature for late summer and fall operations in the hatchery; but, if too warm, some well water at 50° will be supplied to the hatchery. During the winter, the addition of well water to 33° Icicle water will make a 40° temperature in the hatchery troughs feasible. Eggs hatch in the early winter, and fry are held in the hatchery troughs until weather conditions permit placing them in outdoor rearing ponds.

As rapidly as possible, the temperatures of rearing ponds will be raised in spring to and above 52°, probably by supplying water from the Wenatchee River, which is not so cold as Icicle Creek. Well water may be used in summer to keep rearing pond temperatures down, and in winter to keep them up to safe limits.

The hatchery and appurtenant facilities were designed and built by the Bureau of Reclamation on the basis of studies made in cooperation with the Bureau of Fisheries and the Washington State Department of Fisheries. The plant is operated by the Federal Fish and Wildlife Service.

American Society of Agricultural Engineers Convenes in Chicago

THE annual fall meeting of the American Society of Agricultural Engineers was held in Chicago, Ill., December 2–6. Several papers of interest in the fields of soil and water conservation and rural electricity were presented.

1. Dam No. 2—diversion canal to left holding ponds beyond
2. Seining platform and spawning shed
3. Hatching troughs
4. Loading truck at trap
5. Wenatchee Canal
6. West trap and elevator
7. Truck loading at trap

Cultural Development of Milk River Project Farms

By EFFIE R. POND, *Project Home Demonstration Agent, Farm Security Administration*

IT is too early to try to enumerate the advantages, social and educational, of an irrigated resettlement project. So far we have devised no means of measuring certain factors which constitute culture. Security, or a feeling of security, happiness, contentment, and the abundant life are just words which conjure up pictures in our minds—no two alike. But any one of us can recognize at a glance the community that has grown from the soil, blossomed, and borne fruit.

On Milk River farms, in northern Montana, we have the unusual good fortune of being able to observe the beginning of this cultural growth at the same time as later stages of development. Comparisons are obvious. A few new people brought in annually makes this possible. There is the Brown family, just starting out, shopping for second-hand furniture and learning how to plant an irrigated garden; and the Jones family, who, after a year on their farm, know that they need two more milk cows to provide cash for sugar and coffee; and the Hardy family, who, after 3 years, have almost forgotten the past.

Modern Building for School and Social Activities

Many factors contribute to this rapid adjustment. A modern building was erected on a central location by the Farm Security Administration. Arrangements have been made with the local school district to use this building for school purposes. Three rooms are used as classrooms, a fully equipped modern kitchen is used in the preparation of hot lunches, while another large room has a stage for extra social activities. Outdoor playground equipment and a piano were purchased through the efforts of teachers and pupils.

A staff of well-trained farm and home supervisors, specialists in their work, carry on a planned program. Educational meetings attended by all members of the community include canning demonstrations, meat-cutting demonstrations, health courses, and pictures. Probably the most important phase of these gatherings is the chance to talk things over with their neighbors. This helps overcome their characteristic shyness, and develops poise and ability to express themselves. Hidden talents are discovered and leaders brought forward. On Thanksgiving Day a family dinner was served by the women of the community; when Joe Young's boy "brought home a wife" everybody danced; and when the Wilson girl's engagement was announced the community building was the scene of the "shower."

The banquet hall

A Typical Settler

Typical of the 3-year-old settler is the story of John Hardy. Three years ago John was a farm laborer, lived in a two-room cottage located near the owner's farmstead. His rent was free. He and two of his boys worked for the landlord. The boys could thin beets remarkably well for 14-year-olds and were to receive a "school outfit" (overalls, cap, shoes, and blazer) for their work. Local relief agencies assisted some by providing surplus commodities.

Mrs. John Hardy was as timid as a rabbit. In fact, she reminded one very much of that little animal, as doors and mouths were closed at the approach of visitors. She could not read print, but she knew from the way John worried, figured, and planned that they were being pressed for money. Every visitor was a potential collector. This situation was not too serious if just she and John were thrown out of this two-room shack, but motherlike she was thinking of the nine other human beings even more helpless and dependent than herself. There was only one bed, but there was a roof over their heads. Montana Novembers are cold.

Farm Tenant Becomes Farm Owner

The Resettlement Administration came to the assistance of the Hardy family and for 3 years now they have lived in a 6-room house on an 80-acre farm. The farm was rated below average by everyone, the soil was run down, pasture destroyed, drainage poor, and fields were weed-infested. Doggedly, John and his family have worked. Phosphate has been applied; green growth plowed under; weeds burned, pulled, plowed under; and stable manure spread on the fields. He has found time to build fences, lay cement walks around his house, plant and care for a large

A typical farm home

lawn, ornamental shrubs, a shelter belt, and many fruit trees. He has built a large root cellar that is filled with food.

The house is not modern, but like human beings the members of John's family sleep in beds. The family size increased to 12. One baby died. John had his appendix removed. The two older girls are attending high school in Malta, riding to and from school on a bus. One of the girls keeps the family farm and home accounts. John is a 4–H Club leader, and an active leader in the church of his faith. John's wife is still a little shy and timid, but "bursting proud" of their achievements.

Recently 200 brawny farmers and their suntanned wives and children listened politely while a speaker told them all about the evils of modern civilization, our brand in particular. Slight, unenthusiastic applause greeted the ending. It might all be true that our national economic structure was "screwy," that we should "rebuild it from the ground up," but after the races, the potato-peeling contest, the nail-driving contest, the husband-calling contest, the wood-chopping contest, the horseshoe-pitching contest, and the ball game, these farmers were going to drive a modest car to a comfortable home, milk their cows, feed their chickens, gather the eggs, and cuss the mosquitoes.

A typical Sunday gathering

Improvement Activities at Boca Dam

Truckee Storage Project, Nevada-California

FOR the benefit of those not familiar with the Truckee Storage project, a brief review will be made of previously published information concerning this project, particularly so far as such information pertains to construction developments.

The project lands, consisting of some 30,000 acres, are located adjacent to the cities of Reno and Sparks, Washoe County, Nev.; and as part of an old established area, beginning with the earliest water rights of 1862, have been receiving water diverted from the Truckee River for many years. The Truckee River acts as a main canal for the numerous diversion ditches which form the principal laterals of the distribution system, deriving its water supply from Lake Tahoe and the several tributary streams, of which the Little Truckee River is the most important.

Although Lake Tahoe, the source of the main stream, has for some time been used as a storage reservoir, there have been insufficient facilities for conserving the seasonal run-off occurring mainly during the spring months. To offset this disadvantage and to provide, through further conservation, a supplemental water supply, Boca Dam was constructed on the Little Truckee River at a point about one-quarter mile from its confluence with the main stream.

The dam is of the rock-faced, earth-fill type; is 116 feet high above its foundation, 1,629 feet long at the crest; and creates a reservoir having an available capacity of 40,900 acre-feet. The structure is provided with a concrete-lined, open channel spillway with a maximum capacity of 8,000 second-feet, controlled by two radial gates, each 19 by 16 feet. A concrete-lined tunnel, 369.54 feet of which has a diameter of 12 feet, and 315.36 feet a diameter of 10½ by 14 feet, is the main structure of the outlet works. At the end of the 369.54-foot section, there is a gate chamber provided with two 4- by 4-foot slide gates which control the release of water into two 50-inch steel pipes leading to two 42-inch needle valves located at the downstream portal of the tunnel, having a combined capacity of 900 second-feet.

Contracted construction work began April 24, 1937, and was completed August 23, 1939. During operations by the contractor, considerable auxiliary work, such as reservoir site clearing, minor road construction, gaging station installations, and general improvement work, was accomplished by C. C. C. and other Government forces. Because some work was not included in the construction contract and other work was eliminated therefrom, there remained, after August 23, 1939, considerable construction and general improvement work to be completed by Government forces. This remaining work consisted principally of the installation of an auxiliary power plant, the construction of the power distribution system, the installation of the parapet and curb walls along the crest of the dam, the permanent lining of the outlet channels leading from the spillway and the outlet works, the removal from the reservoir area and relocation of a portion of the existing water system, some structure and general drainage installations, and a variety of protective and general improvement work.

Before the 1939–40 winter season prevented further progress, the auxiliary power plant was installed in the building which had been used as a laboratory during contract work, and the power-distribution system for operating and lighting the spillway and outlet works was completed.

By the end of the first week in June 1940, the C. C. C. camp had been reestablished at Boca Dam and work commenced by enrollees of that camp. Progress was somewhat retarded during June on account of the loss and replacement of enrollees necessitated by the expiration of enrollee enlistment periods, but by July 10 activities had been well organized and good progress was being made.

Winter conditions had damaged existing roadways, so reconditioning and improving the roads into and about the dam and reservoir area became the first activity. There immediately followed the construction of some new roadways necessary in connection with the larger features of work contemplated. With conditions thus improved, so that the transportation of materials was facilitated and work sites made more accessible, forces were concentrated on repairs to the spillway outlet channel and toward placing permanent rock riprap on the slopes of that waterway. The placing of hand-laid, large rock lining in the first section of the channel immediately below the stilling basin is now practically complete, and the material so placed forms a comparatively solid rock blanket, 3 feet thick, with a very uniform exposed surface. Downstream from this section, the channel section changes to a combination of side slopes so that riprapping of the upper slope only, to an average thickness of 1 foot, was considered necessary. Hand-placing of the foot-thick riprap in the lower length of the channel was not

Needle-valve house, downstream slope of Boca Dam at west abutment, and CCC camp. Road construction and drainage installations partially completed

required, as the objective was mainly a stabilization of channel banks, formed principally of fill material, against surface run-off. As snow and resulting local run-off conditions are frequently serious at Boca Dam, more than the average protective measures, such as riprap and drainage installations, are necessary for permanent construction.

During the progress of the larger job, all forces not necessary thereon have been employed at various smaller or minor activities. A standard weather and evaporation station has been installed according to United States Weather Bureau standards. For some time certain weather recording instruments have been in use, by which cooperative reports have been made through the Reno offices of this and the Weather Bureau; those instruments are now incorporated into the improved station. It is believed that the evaporation records now made possible will be exceptionally valuable in connection with Boca Dam operation. Improvements are also being made to the grounds immediately adjacent to the Government buildings. This area has been properly graded, provided with fertile top soil, and is being fenced and planted to lawn for generally improved appearances and the protection of existing buildings. Work is constantly in progress on the roads throughout the area for the purpose of bringing these roads into a more permanent condition, with adequate drains and surfacing. The heavy visitor traffic and the need for good construction, to offset severe winter conditions, make such work necessary.

The Boca Dam area, located in the Sierra Nevada Mountains, is rugged and, as previously indicated, subject to heavy snowfalls. On this account, seepage and springs from natural underground reservoirs and ground storage are frequent. This condition is an advantage in many respects, such as providing excellent and plentiful domestic water; but adjacent to the constructed works, more than the usual protective drainage is required. In this connection considerable work has been accomplished, and is in progress, toward determining the source of such springs and lines of seepage and in providing suitable drains for the protection of structures and the betterment of appearances. One such drain, about 290 feet long, consisting of 8-inch open drain tile laid in a bed of gravel at the bottom of a trench, is being placed along the hillside at the west abutment of the dam. Another drain of similar construction, but only about 144 feet long, is being constructed along the east side of the spillway stilling basin. The latter drain is for the purpose of intercepting water flowing from a deep spring which was encountered during construction of the spillway stilling basin structure. More such drains may be found necessary after further study of the local conditions.

Additional improvements, so far this season accomplished or placed in progress, consist of the completion of a bridge and guard rails across the Little Truckee River immediately below the dam; improvements to previously constructed stream gaging stations; the removal of undesirable structures and debris; the filling of test pits left from investigations; and some landscaping.

Upon completion of the spillway outlet channel riprap lining, it is intended to concentrate available forces on what is considered the next most important job—that of lining the channel leading from the outlet works—and it is expected that this job will be completed this fall.

No attempt has been made to construct the parapet and curb walls this season as that work is considered a full season job for the forces and facilities available.

Looking down spillway outlet channel of Boca Dam. Riprap work in progress

Boating on the Grand Coulee Dam Reservoir

THE western end of Long Island Sound is admittedly the haven of the largest number of pleasure craft in the world, but the nucleus of a new group, nearly 3,000 miles to the west, will soon claim its share of prestige in yachting circles.

The 150-mile lake being formed behind the Grand Coulee Dam is going to affix the title of "Captain" to the names of many unsuspecting dry-land inhabitants of the Inland Empire when they realize the possibilities so near at hand. The formation of the reservoir, with its widening of the shore line, had scarcely begun before some of the "sailors" of former days started to discuss boating on the new lake.

In the spring of 1939 a group of boat enthusiasts from the several communities in the area met to make plans for a yacht club. After a few meetings, a club known as the Grand Coulee Dam Yacht Club, Inc., was formed. Its membership this year slightly exceeds 100, with about half the members owning boats. Membership is available to anyone in the area who is interested in boating. The moderate initiation fee was designed to further encourage the people in use of the splendid recreational features of boating.

A pennant, symbolical of the dam, was selected. It consists of a cross-section of the dam in yellow, mounted on a triangular-shaped flag of blue.

The safety boom which was strung across the channel to protect the boats from danger within the construction zone of the dam was furnished by the Government, as were also docking facilities which are under lease to the Yacht Club. The dock consists of a substantial floating walk with individual slips for 42 boats. The dock is so constructed that additional slips or moorings can be added easily.

The club collects mooring rentals from those members who own boats, and remits most of this amount to the Government in yearly payments as prescribed by the terms of a lease.

Club Assisted by Contractor

A certain amount of protection for the boats is provided by a caretaker and his wife who are established on the dock. The caretaker is regularly employed on the project, and for his services as watchman, the Yacht Club provides him with a house for two people; electrical power for heating, cooking, and lighting; water; and telephone service. In this connection, the general contractor, Consolidated Builders, Inc., has contributed to the success of the club in many ways, including the furnishing of the electrical power and water supply.

The Yacht Club sponsors a group of boys who have formed a local chapter of the Sea Scouts, a national organization closely allied to the Boy Scouts of America. These boys under the leadership of a skipper and governing board have been engrossed in the rebuilding and "fitting-out" of a 26-foot navy whale boat, which will be their training ship. Such discarded hulls are obtained from the United States Navy by Sea Scout groups all over the country, and prove to be extremely valuable in training the boys in maintenance of boats, navigation, sailing, power boating, and general seamanship.

Most of the present club members, being construction men, are not permanent residents of the community; and it is natural that they would have smaller, less expensive boats. Many of the boats are runabouts and speedboats, built by the members and powered with either outboard or inboard motors, having a wide range of speed up to 40 miles per hour. In addition to the fleet of small boats characteristic of all yacht clubs, two members have modern cruisers, one 26 feet and the other 34 feet long, while still another will take delivery of a 28-foot cruiser in the spring of 1941. Sailboat enthusiasts are also represented by six boats of the centerboard type.

The main event of the season has been the annual race for the Commodore's cup. The winner of the event has the honor of having his name engraved on the gold cup which becomes his property until he is defeated. All boats, regardless of speed or size, can participate in this race. The captains, having selected their individual constant rate of speed, start the race at a time which will allow their return to the finish line at a predetermined hour. During the race, an observer is assigned to each boat and it is his duty to see that the pilot does not have a timepiece after crossing the starting line and that no adjustments are made in the controls.

In running the 15-mile course selected, a surprising degree of accuracy has been obtained. The winner of the 1939 race missed the finish time of 3 p. m. by 10 seconds, while the winning boat of 1940 was 25 seconds overtime.

Upper: The *Miss Coulee* at Whitestone—passenger excursion boat operated by the Grand Coulee Navigation Co.

Center: The *Julie Ann,* one of the numerous powerboats owned by members of the Yacht Club, at the Grand Coulee Dam

Lower: Surfboarding, Grand Coulee Dam Reservoir

The commercial possibilities of the reservoir have already been investigated, and a 150-passenger excursion boat, named *Miss Coulee*, was launched this year by the Grand Coulee Navigation Co. The double-decked boat is 65 feet long, and is powered with 420 horsepower to produce a cruising speed of 16 miles per hour. The boat caters to tourists and large parties under charter.

In addition to the *Miss Coulee*, the Davis Water Taxi Service went into operation this summer with two speedboats of 5- and 12-passenger capacity. The tourists are given a short, fast ride a few miles up the lake for a nominal charge.

The recreational features of the Grand Coulee Dam Reservoir will really begin to unfold for the public when the dam is completed in 1941. Recreational centers will doubtlessly be established along the shores of the reservoir, which probably will be stocked with an abundance of game fish. Many miles of highway will border the shore lines, connecting the lake with the main highways. There will be many opportunities for private interests to build tourist camps and to provide boats for fishing. These are but a few of the possibilities for pleasure and enterprise that will be forthcoming when the lake has reached its entire 150-mile length, bringing still water in the Columbia River to the Canadian border.

Gov. John E. Miles signing register at Reclamation exhibit

Reclamation Represented at County and State Fairs

Tucumcari Project, New Mexico

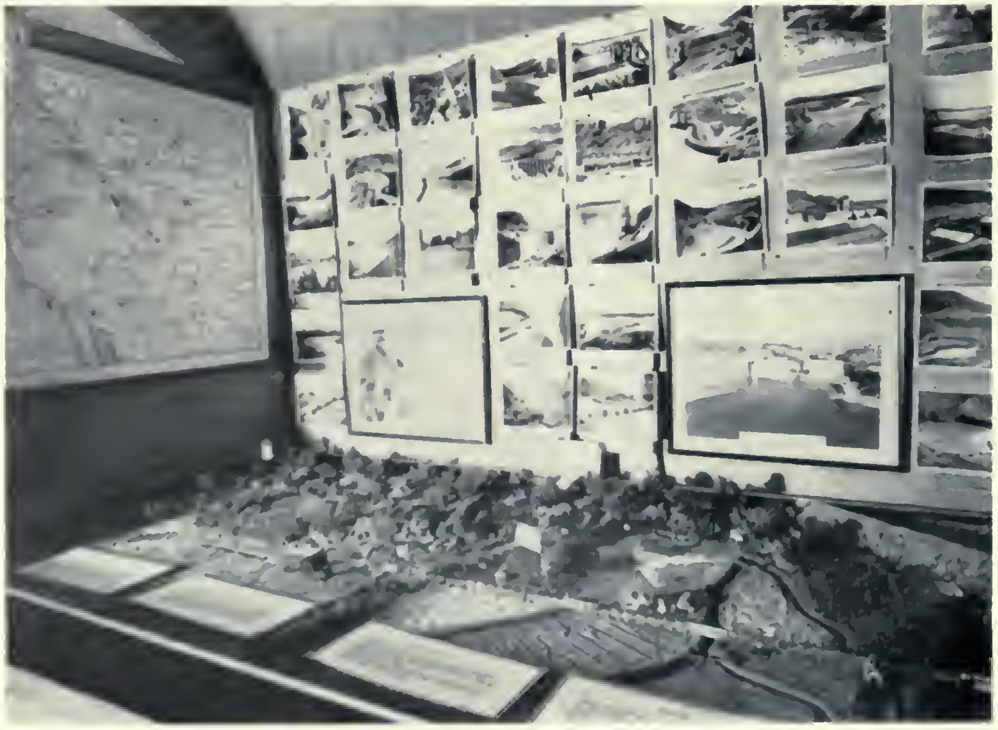
By CHARLES L. LeFEBER, *Assistant Engineer*

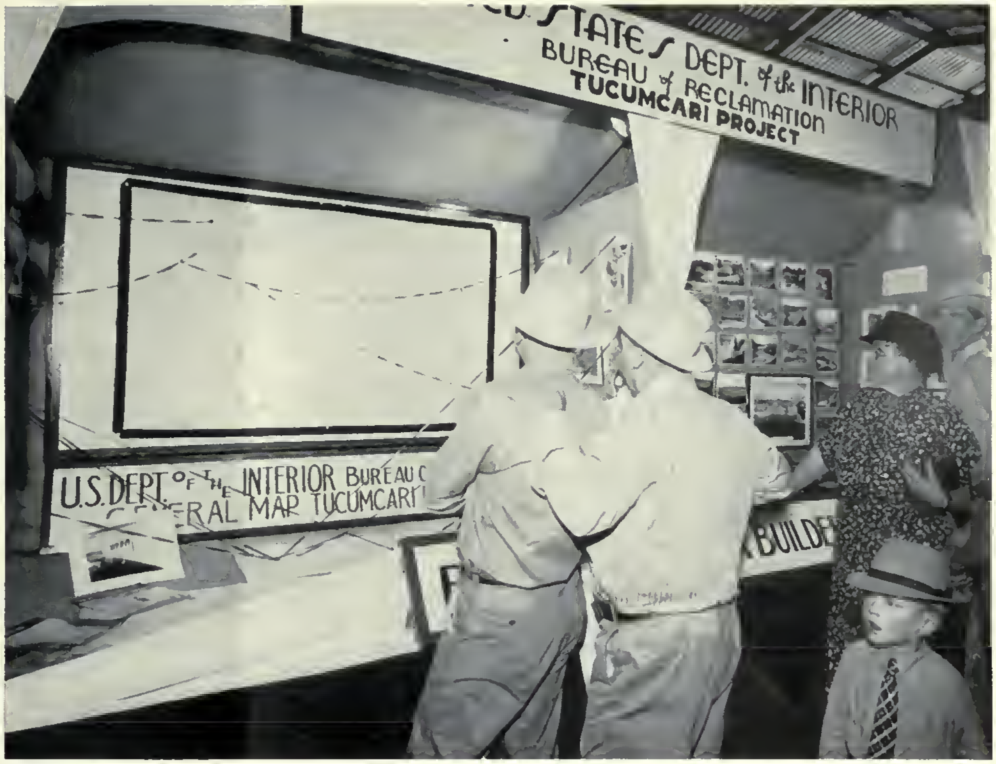
DURING the week preceding the Quay County Fair which was held September 18 to 21, inclusive, space for an exhibit by the Bureau of Reclamation was arranged for and necessary details for the selection of a booth were attended to. Owing to the limitation of time the Commissioner, at the request of the project for exhibit material, provided a selection of 33 pictures, previously prepared, of dams constructed by the Bureau. J. D. Corlis and W. O. Johnson, Bureau carpenters, donated time and constructed a model of a fictitious irrigation district, which in detail showed a reservoir, dam, outlet works, main canal, laterals, turn-outs, irrigated farms, farmhouses, a highway, transmission and telephone lines, and many other features. The photographer prepared numerous enlargements of project construction pictures and the drafting department assisted by preparing explanatory notices and cards. Signs were painted and prints, specifications, and a large topographic map of the project were mounted.

The assembling of the booth at the Quay County Fair was carried out in good order. The available space, measuring 8 by 16 feet, was divided into two equal portions. The left portion was occupied by the large topographic map of the project area placed in the rear of the compartment. On the floor of the space was placed a general map of the entire canal location, and grouped around this were various pictures of the work in progress. Scenes of construction activity were also placed on the two sides of this left compartment and red ribbons were stretched from the pictures to the two maps in such a way as to indicate on them each site represented by the corresponding picture in the surrounding group. Closer to the observer were placed copies of the Reclamation Era and of the specifications and plans of structures for the project. In front of this a large sign was arranged as a barrier to prevent undue crowding of the exhibit and upon it was painted "Department of the Interior, Bureau of Reclamation—General Map—Tucumcari Project."

In the right compartment of the exhibit was a large map of all Reclamation projects, showing their location in the western part of the United States. This map was hung on the left side of the compartment and the rear wall was entirely covered with pictures portraying Reclamation dams. Two large pictures of Conchas Dam, under construction, were also hung in this space. On the right wall were hung additional enlargements of project activities showing four stages of development, namely, investigations, surveys, construction, and service, or project use

Right section of exhibit at Quay County Fair





General view of exhibit

These four stages were adequately described by large printed cards.

The entire floor of this compartment was occupied by the previously described model of an irrigation district. In front was placed another large sign acting as a guard rail upon which was printed, "Reclamation, a Builder of the Nation."

Between the two compartments were placed a small writing board and a register for the signature of visitors. Both compartments were roofed with an arched ceiling, painted blue, and were illuminated at all times by special reflector bulbs. The booth was curtained at the base by red flagging and all trim was in red, white, and blue. The entire exhibit was very colorful and occasioned much comment by visitors. More than 400 signatures were obtained from interested persons, and by actual count it was estimated that nearly 4,000 passed by and had their attention attracted to the booth during the 4 days of the fair. Gov. John E. Miles, of New Mexico, a distinguished visitor, also signed the register.

Various employees of the Bureau were assigned to explain any portions which might be of interest to the visitors and as a result of this, much information was given out.

At the conclusion of the fair, it was learned that Quay County would not be able to utilize the space assigned to it at the New Mexico State Fair whereupon permission was granted the Bureau of Reclamation to occupy the space, and on Monday, September 23, Mr. Johnson, accompanied by R. E. Srote as helper, took the exhibit by pick-up truck to Albuquerque where the State fair is held. The writer accompanied the exhibit and acted as lecturer during the fair.

As it was found impossible to transport the model of the irrigation district without completely ruining it, the exhibit was arranged without this feature. A very favorable location for the exhibit was provided; however, it was necessary to build a more elaborate booth than was required at the Quay County Fair, as the space obtained (by much persuasion) was at a very advantageous spot at one of the entrances to the agricultural building, and placed in the line of all visitors. This arrangement made a most impressive exhibit, as our booth was entirely separate from the other exhibits and was made to stand out by a brilliant lighting system.

Signatures of interested visitors numbering more than 2,000 were obtained and there were many from all parts of the United States. The most distant visitor registered was from Indochina.

A National Defense Message to Women

ON October 22, 1940, Miss Harriet Elliott, commissioner in charge of the production division of the National Defense Advisory Commission, delivered an address before the New York Herald Tribune Forum in New York City on the subject of Woman's Part in Defense Plans. Excerpts follow.

I am directing some of the following suggestions to the women of America.

Your first patriotic duty is very personal—it is your responsibility to know the facts concerning this world crisis and to be prepared to assist others in understanding it. This is no time for haphazard conversation and guesswork on the vital problems of the day.

I cannot stress too strongly the need for all of us to keep informed regarding our local, national, and international situations. A well-informed citizen—and in a democracy there is no reason to be uninformed or misinformed—is a national asset. Knowing why and where and how is an effective brake on hysteria and general confusion arising from ignorance of facts. During a period of crisis, rumors are rampant. The well-informed person can differentiate between rumor and fact and can be instrumental in correcting false impressions before they create widespread suspicion and panic. Knowing and understanding the vital factors in national affairs creates a psychological defense which is a real contribution to total defense.

Civic organizations and social groups and club women particularly can be very effective in combating misinformation designed to instigate unrest and distrust. They can develop educational programs and study courses for their memberships. They can encourage constructive discussion groups and open forums, inviting the participation of the public and thus promoting and encouraging an informed citizenry which is the intellectual strength of a democracy.

This then is my primary suggestion to those who want to do something for national defense. Know what is happening in the world today. No one can be too well informed or know too much about national and international affairs. Key your winter study programs to national and international conditions. To inform yourself and others is an important contribution to total national defense.

Another vital contribution to be made to the national program is defense on the "home line front." It is in the home and local community that "total defense" attains its full significance. The better our homes are organized; the more service our schools, churches, and local organizations can give our communities, the better prepared we will be as individuals to meet whatever demands the future may make of us. I suggest that each of us know our own community and take a personal and active responsibility in its improvement. Intensify and coordinate the work of your local civic and service organizations. I am sure that every organization represented in this audience has a committee which for years has been working on some social community problem. You should make these committees 100 percent effective. If they were necessary in so-called normal times, they have even greater importance in a time of national crisis. Women all over America are saying, "What can I do for defense?" I am saying to them, "Get busy on the community-line front." America is no stronger than the sum total of the local communities. Strengthen the weak links in your community life and social well-being. They may be found in the fields of health, nutrition, recreation, and child care. If you are not playing your part to improve your local community life, then you are missing an opportunity to do a first-line defense job.

Do your part to make life for every individual in your community an experience in democratic living. Make plans which will include all women, from every section of your city and county, not just the organized groups. A few leaders cannot make the home front 100 percent effective. When you are planning for community defense effort, be sure total community resources are included and not just a part. Our defense program will require the cooperation of everyone. A small committee in your organization may be doing good work, for example, in a child welfare program. I suggest that you expand such activities and encourage the working cooperation and interest of women who may not be members of your group. You might draw other women into the work who could make a real contribution to your organization and its program, if given the opportunity.

To those who say "We already serve our communities—we can do all this and more—we want to go on a full-time service schedule," I want to suggest the development of proficiency in one or more phases of welfare and social service. For instance, women with sufficient leisure time can take courses in nursing. Under the instruction of experts, they can train themselves in first-aid treatment, in the fundamentals of practical home nursing, and in the care of ill children. They can prepare themselves to serve as community nurses in time of emergency. This does not mean that all women need become professional registered nurses but only that they should develop nursing skills for an emergency. Physical fitness is a vital part of total national defense.

Some women may prefer to study dietetics. Knowing the protective foods necessary for health and strength is a first step in promoting physical well-being. Proper nutrition is as important for adults as for children. Learn what foods are abundant; know strategic foods and their substitutes, how to buy and prepare them. Learn these facts about food under the direction of competent home economic teachers. Women can be instrumental in providing their community with a municipal radio market news service to advise householders on the best buys in foods each day. They can encourage diet clinics where mothers can bring their food-buying problems and talk them over with experts in nutrition and consumer buying. Again I call your attention to the total need. Make plans to assist all women in your community to learn the basic facts of good nutrition. In every State nutrition committees, directed by experts, are organized or will be organized under the State councils of defense. These experts will assist you in developing food study programs. They will assist you in creating diet clinics. You can assist them by encouraging mothers to bring to these clinics their diet problems.

We in the Consumer Division, under the direction of Dr. M. L. Wilson, Director of Extension Service, of the Department of Agriculture, are developing a nutrition program in which every woman in America can participate. If you do this job well, you will have made a great contribution to the effort to make America strong. Stamp out malnutrition in America by eliminating it in your own community. Strength is essential to total national defense.

Encourage the expansion of educational and recreational programs. Make yourself responsible for an underprivileged American child—an American refugee from the ravages of undernourishment and poverty. See to it that every child in your neighborhood has at least one well-balanced meal a day. See to it that your community provides recreational facilities for young and old alike.

There has never been a time in our history when it was more necessary to provide recreation in drama, music, community-sings, games, and playhouses for all people. The relaxation which comes from proper recreation will relieve the nervous tension and mental strain generated by daily front-page strains and radio broadcasts about our war-torn world. This is a job to do—right on your own doorstep.

I have heard people say, "Why don't you get women to work at gathering scrap iron, old rubber, and tin?" Gather scrap iron when it is needed.

In this world crisis we all go about our daily tasks under something of a mental and emotional strain. You have an opportunity, through proper community services, to help us all build up a spiritual and physical reserve which we may need as the days go by.

You can help prepare our young people for their citizenship duties of tomorrow by encouraging them to develop responsibility in community life. Include them in your plans to promote better democratic living.

These suggested roles are not glamorous. They are not dramatic. They will not make the headlines, but if you follow and develop them you will provide the bulwarks of national defense. Before you decide what your defense work will be, study the needs of your community, analyze your own ability, and select that service which you believe will make the greatest contribution to better defense and better living in your community.

Traveling Cranes for Shasta Dam Power Plant

THE Shasta Dam power plant, Central Valley project, California, has on order two traveling cranes, each capable of carrying 250 tons.

The contract for furnishing this equipment was awarded to the Lakeside Bridge and Steel Co., of Milwaukee, Wis., on its low bid of $172,560.

The cranes will be of the electrically operated indoor, overhead, traveling type, and will operate on runways approximately 380 feet long. Each crane will be equipped with two trolleys and each trolley will bear a 125-ton main hoist and a 25-ton auxiliary hoist. Power will be supplied from rigid conductors mounted above the crane runway rails. The span of each crane will be 65 feet 2 inches from center to center of the crane runway rails.

These cranes will be used in connection with the assembly and maintenance of hydroelectric equipment in the Shasta power plant, which is designed for an ultimate installation of five generating units, each to consist of a 103,000-horsepower turbine and a 75,000-kilovolt-ampere generator. The heaviest part of each generator will be the generator rotor, weighing about 450 tons. The rotors will be lifted by the two cranes working together through a special lifting beam attached to the main hooks of the cranes.

Already on order for this power plant is equipment for four main generating units and two smaller station-service units, which will comprise the initial installation in the powerhouse.

The contractor is required to deliver the cranes within 210 days after receipt of notice of the award of contract.

Structures on Parker Dam Power Project To Be Protected

IN accordance with a ruling dated November 15, 1940, visitors are now to be excluded from the Parker Dam and construction area, and appropriate signs have been installed alongside the road at Earp, Calif.; at the highway junctions at Hope, Ariz., and Desert Center Calif., and, if found necessary, will be placed at Needles and Blythe, Calif.

Special visitors will be permitted, by prior arrangement at the project office, and each visitor or group of visitors will be provided with an escort to show them over the dam or job Visitors directed to the restricted area by other Government offices or by the Metropolitan Water District must be provided with suitable written requests.

Mancos Project, Colorado, Approved for Construction

THE Mancos project in Colorado was approved for construction on October 26, 1940, the eighth "work relief" irrigation development to be undertaken by the Bureau of Reclamation, and the second within a week.

The "work relief" projects aim at stabilizing the agricultural life of the regions in which they are built. They employ WPA and CCC labor in their construction, and offer settlement opportunity for the landless and jobless. The cost of the Mancos project is estimated at $1,600,000, of which $680,000 will be repaid by the farmers in not more than 40 annual installments.

The reimbursable portion of the cost comes from the $8,500,000 made available by Congress for the construction of Great Plains and other work relief irrigation projects under the Case-Wheeler Act of 1939 and the Interior Department Appropriations Acts of 1940 and 1941. The balance of the cost comes from WPA and CCC allocations of labor and materials.

The Mancos project lands comprise 10,000 acres in Mancos Valley, one of the oldest irrigated sections in western Colorado. The valley was settled more than 60 years ago, but an unregulated and inadequate water supply has stifled the valley's economic progress for many years.

At present it is practicable to raise only grain and forage crops even though the soil and climate of the valley are adapted to other crops. About half of the 10,000 acres in the project area has been actively cultivated in recent years.

The construction of the project by the Bureau of Reclamation will provide a dependable supplementary supply of storage water which will protect the valley from drought and permit more diversified farming and will foster community development and economic growth. A badly needed water supply will also be made available for the Mesa Verde National Park.

Additional Structures

An offstream dam to create a reservoir of 10,00 acre-feet capacity will be built on Jackson Gulch, about 4 miles north of Mancos. An

(*Continued on page 356*)

NOTES FOR CONTRACTORS

Specification No.	Project	Bids opened	Work or material	Low bidder		Bid	Terms	Award of contract approved
				Nama	Address			
934	Boulder Canyon, Ariz.-Nav.	Oct. 11	One 23,000-volt hus structure and 1 transformer neutral bus structure for unit A-5, Boulder power plant.	Bowia Switch Co	San Francisco, Calif.	$37,110.00	F. o. b. Boulder City	Oct. 23
935	Yakims-Roza, Wash.	Oct. 10	Earthwork, pipelines and structures, laterals G-29.3 to G-40.4, and sublaterals, Yakima Ridga Canal.	Ray Schweitzer and Fife & Co.	Parma, Idaho	[1] 66,201.52		Oct. 29
933	Klamath, Oreg.-Calif.	Sept. 27	Construction of Tula Lake Tunnel, Modoc division.	J. A. Terteling & Sons	Boisa, Idaho	172,096.00		Oct. 30
929	Central Vallay, Calif.	Sept. 6	Two 250-ton traveling cranes for Shasta power plant.	Lakesida Bridge & Steel Co.	Milwaukee, Wis.	172,560.00		Do.
1435-D	Parker Dam Power, Calif.-Ariz.	Oct. 10	Gantry crana, 100-ton capacity, for Parker power plant.	Cyclops Iron Works	San Francisco, Calif.	75,752.00	Discount ⅛ percent	(9)
1439-D	Columbia Basin Wash.	Oct. 7	Ona 200-ton, motor-driven, transformer transfer car for Grand Coulee power plant.	The Atlas Car & Manufacturing Co.	Cleveland, Ohio	6,425.00		Oct. 22
E-23, 187-A	Boulder Canyon, Ariz.-Nev.	Oct. 10	Cable	Ryall Electric Supply Co	Denver, Colo	19,344.14	F. o. b. Boulder City, Nev. Discount ½ percent.	Nov. 5
1443-D	Columhia Basin, Wash.	Oct. 29	Frames for shuttle-crane carriaga and frames for storaga pit installation for shuttlo crana and carriage in left abutment.	Valley Iron Works	do	10,850.00	F. o. b. Yakima, Wash. Discount 1 percent.	Nov. 7
1446-D	Tucumcari, N. Mex.	Oct. 28	Radial gates and hoists	R. E. Schreffler Co	do	[7,8] 1,422.00	F. o. b. Yakima, Wash. Discount ½ percent.	Nov. 4
1448-D	Colorado-Big Thompson, Colo.	Oct. 30	Seal seats for bulkhead gato at Green Mountain Dam.	National Iron Co	Duluth, Minn.	1,565.00		Nov. 6
1442-D	Klamath, Oreg.-Calif.	Oct. 25	Pumping units for No. 10 drain pumping plant.	Sterling Pump Corporation	Stockton, Calif.	2,225.00		Nov. 7
1445-D	Parker Dam Power, Ariz.-Calif.	Oct. 31	Metalwork for trashracks for intako structure at Parker power plant.	American Bridga Co	Denver, Colo	4,805.00	F. o. h. Gary, Ind	Do.
1449-D	Colorado River, Tex.	Oct. 30	Turntabla for handling outlet gates at Marshall Ford Dam.	Fort Worth Structural Steel Co.	Fort Worth, Tex.	1,441.00	Discount ½ percent	Do.
1432-D	Columhia Basin, Wash.	Oct. 3	Ventilating equipment for Grand Coulee power plant.[8]	The New York Blower Co	Chicago, Ill	[1] 4,474.00	F. o. h. Odair, Wash	Nov. 6
				Chelsea Fan and Blower Co., Inc.	Now York, N. Y.	[2] 832.28	Discount 2 percent	Nov. 9
				McQuay, Inc.	Minneapolis, Minn.	[3] 311.20	F. o. h. Odair, Wash. Discount 2 percent.	Nov. 12
				Anemostat Corporation of America.	New York, N. Y.	[6] 1,033.19	F. o. b. Hartford, Conn.	Do.
E-23, 146-A	Boulder Canyon, Ariz.-Nev.	Sept. 12	Induction motor with control and switching equipment.	General Electric Co	Schenectady, N. Y.	14,764.00	F. o. h. Boulder City, Nev.	Nov. 16
1427-D	Parker Dam Power, Ariz.-Calif.	Oct. 1	Ventilating and air-conditioning equipmant for Parker power plant.	The New York Blower Co	Chicago, Ill	[1] 699.00	F. o. b. Earp, Calif	Nov. 15
				Hendria & Bolthoff Manufacturing & Supply Co.	Denver, Colo	[2] 830.40	F. o. b. Buffalo and Denver.	Nov. 13
				The Trano Co	La Crosse, Wis.	[3] 236.30	F. o. b. Earp, Calif	Nov. 14
				Refrigerating & Power Specialties Co.	San Francisco, Calif.	[4] 631.30	do	Nov. 15
				Harry M. Pottorff	Los Angeles, Calif.	[5] 749.40	F. o. b. Earp, Calif. Discount 3 percent.	Nov. 14
				Griffith Pipo & Supply Co	do	[6] 25.10	F. o. b. Earp, Calif. Discount 2 percent.	Nov. 13
1444-D	Colorado-Big Thompson, Colo.	Oct. 30	Trashracks for outlet works at Green Mountain Dam.	The Ornamental Iron Work Co.	Akron, Ohio	5,524.00	F. o. b. Kremmling, Colo. Discount ½ percent.	Nov. 16
1447-D	Buford-Trenton, N. Dak.	Nov. 1	2 motor-driven pump units	Food Machinery Corporation (Pearless Pump Division).	Los Angeles, Calif.	14,414.00	F. o. b. Los Angeles (pumps); Buford, N. Dak. (motors).	--------

[1] Schedule 1. [2] Schedulo 2. [3] Schedulo 3. [4] Schedulo 4. [5] Schedule 5. [6] Schedule 6. [7] Items 1 and 2. [8] No bids received on schedules 4, 5, and 7. [9] All bids rejected.

Construction on Modoc Division Klamath project, Oregon-California

THE first feature to be constructed on the Modoc division of the Klamath project in Oregon and California will be a tunnel to carry pumped water from Tule Lake to Lower Klamath Lake, and contract for this work has been awarded to J. A. Terteling & Sons of Boise, Idaho, submitting to the Klamath office of the Bureau of Reclamation the successful bid of $172,006.

The contract covers the construction of a concrete-lined, horseshoe-type tunnel, 7,000 feet long with a diameter of 5 feet 9 inches, involving the excavation of 24,350 cubic yards of material and the use of 3,100 cubic yards of concrete in tunnel lining, in addition to furnishing and installing steel tunnel supports and other work. All of the work must be completed within 500 days.

The Bureau of Reclamation and the United States Fish and Wildlife Service worked out jointly a plan for the construction of this new division of the project, called the Modoc Unit, which will improve certain conditions that have developed on the Klamath project. The project operations have resulted in the unwatering or draining of Lower Klamath Lake, which is separated from Tule Lake by a range of hills. The portion of the lake bed lying in California has been found to be unsuitable for general farming purposes because of soils and alkali conditions. The prevailing westerly winds collect the dust from this dry lake bed with the result that portions of the project are subjected frequently to dust storms that cause considerable distress. The flooding of the lake for a bird refuge and the irrigation of border lands will eliminate the dust nuisance which endangers the health and well-being of the settlers. The Tule Lake sump has been developed by the United States Fish and Wildlife Service as a bird refuge but fluctuating water surfaces of Tule Lake are unsatisfactory for propagation and the stagnant waters cause botulism. Heavy rainfall has increased the flow into Tule Lake sump to the extent that dikes have broken and much property and even the safety of the homesteaders on the Klamath project are endangered.

This tunnel, the first and most important construction feature of the Modoc division, will carry excess water pumped from Tule Lake through the ridge of hills into Lower Klamath Lake basin. About 50,000 acre-feet of water will be pumped annually, and approximately 15,000 acre-feet of the pumped water will be used to irrigate some 11,000 acres of land in the basin area for pasture and crops. The balance of about 35,000 acre-feet will restore the water area in Lower Klamath Lake and establish a wildlife refuge of about 17,000 acres which will be of great strategic importance in the Pacific flyway. The restoring of water in Lower Klamath Lake will also prevent recurrent dust storms which plague the surrounding agricultural and urban areas. In pumping water from Tule Lake the water area in the lake will be maintained at a uniform level and protect from flooding about 20,000 acres of highly productive land around Tule Lake which have been farmed for several years.

Additional construction features of this new division will consist of a pumping plant to supply the tunnel, which will be composed of three units with a combined capacity of 150 feet per second, and three other pumping plants, as well as dikes, spillways, canals, and drains.

Death of R. O. Chambers

NOTICE has been received in the Washington office of the sudden death on November 26 of R. O. Chambers, longtime president of the Pathfinder Irrigation District. Mr. and Mrs. Chambers were riding in the family car when a collision with a motor bus occurred between Utica and Waco, Nebr., in which Mr. Chambers was killed and Mrs. Chambers suffered critical injuries.

E. C. Koppen Dies

TO his many friends through the Reclamation territory notice of the sudden death on November 25 of E. C. Koppen, construction engineer of the Parker Dam power project, with headquarters at Parker Dam, Calif., will be received with profound regret.

A more detailed statement concerning Mr. Koppen's official connection with the Bureau and of his death will appear in the succeeding issue of the ERA.

Death of Harry Crain

NOTICE has been received in the Washington office of the death at Silver Springs, Md., on November 13 of Harry E. Crain, well known in Reclamation circles as a Wyoming pioneer and member of the party that appraised the land now covered by Lake Mead, the reservoir impounded by Boulder Dam.

At the time of his death Mr. Crain, a resident of Cheyenne, Wyo., for 57 years, was visiting his daughter, Mrs. Ena Thompson, in Washington, where he had been ill for several days following a heart attack.

A native of Springfield, Vt., Mr. Crain took up residence in Wyoming as a cowboy on a ranch north of Lusk when he was 19 years old, moving to Cheyenne in 1883, where for a number of years he was employed as an appraiser for many large cattle companies, and later worked in the same capacity for banks and other financial institutions.

He served his State in several important assignments and was elected to the State legislature in 1904, in which he served three successive terms.

In 1894 he formed a partnership with D. McCallum in the lumber business at Wheatland, and 6 years later opened a similar business in Guernsey.

Mr. Crain is survived by his daughter and a sister. His body was returned to Cheyenne for interment.

Paprika Peppers—Yakima

THE growing of paprika peppers in the Yakima Valley has been urged as a profitable addition to the valley products by a grower who has had some success in producing the crop in Oregon and expects to plant 40 acres in the Yakima Valley in 1941. He considers this valley especially adapted to the growing of this condiment. Interested parties and producers are investigating the possibilities of the proposed new industry.

Orland Cattle Score at Fair

HOLSTEINS of the J. N. Cook herd of Orland, and their cousins of the Kingsley herd of Ord, exhibited together at the Lassen County Fair, cornered the most coveted honors of the show. Among the prizes captured, the Glenn County entry was first in the milking contest; first in herds and second and third in individuals, against a field of 20 entries.

SALMON FOR SUPPER

(See opposite page)

Did you think salmon grew in cans? To protect a foremost industry of the Northwest, the Bureau of Reclamation adopted a migratory fish program in connection with the Grand Coulee Dam project. Since the dam became too tall to be vaulted by Pacific Ocean salmon, whose instinct leads them to home waters at spawning time, they are trapped at Rock Island Dam, located on the Columbia River nearer the ocean, and transported by truck to the Leavenworth hatchery in the foothills of the Cascades. Shown at the upper right is the hatchery; at lower left, the shed where 50,000,000 eggs in trays are stacked in troughs, and flowing water circulates over them for a 5-week period prior to hatching; at the upper left is a fine specimen of Chinook salmon; at lower right an inspector counts his salmon before they're hatched.

Mancos Project

(Continued from page 353)

inlet canal with a capacity of 250 cubic feet per second and approximately 3 miles long will take water from the West Mancos River and deliver it to the reservoir, releases from which will be returned to the river by an outlet canal of 200 second-feet capacity. The dam will be an earth-fill structure 130 feet high above the stream channel and 1,930 feet long across the crest.

The distribution system for the project lands has already been constructed. Some revisions may be necessary and additional farm ditches probably will have to be dug in connection with the land development program.

The Bureau of Reclamation will operate the dam after it is built and negotiate contracts with the beneficiaries for the repayment of construction and operation and maintenance charges. The land development, including any necessary rehabilitation or revision of the distribution system and the required leveling of rough land, is planned to be undertaken by the Department of Agriculture, which will also negotiate contracts with the beneficiaries for repayment of development and settlement charges.

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Very truly yours,

December 1940

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NOTE. 36 cents postal charges should be added for foreign subscriptions.

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Projects under construction or operated in whole or in part by the Bureau of Reclamation

Project	Office	Official in charge		Chief clerk	District counsel	
		Name	Title		Name	Address
All-American Canal	Yuma, Ariz	Leo J. Foster	Construction engineer	J. C. Thrailkill	R. J. Coffey	Los Angeles, Calif.
Altus	Altus, Okla	Russell S. Lieurance	Construction engineer	Edgar A. Peek	H. J. S. Devries	El Paso, Tex.
Belle Fourche	Newell, S. Dak	F. C. Youngblutt	Superintendent		W. J. Burke	Billings, Mont.
Boise	Boise, Idaho	R. J. Newell	Construction engineer	Robert B. Smith	B. E. Stoutemyer	Portland, Oreg.
Boulder Canyon [1]	Boulder City, Nev	Irving C. Harris	Director of power	Gail H. Baird	R. J. Coffey	Los Angeles, Calif.
Buffalo Rapids	Glendive, Mont	Paul A. Jones	Construction engineer	Edwin M. Bean	W. J. Burke	Billings, Mont.
Buford-Trenton	Williston, N. Dak	Parley R. Neeley	Resident engineer	Robert L. Newman	W. J. Burke	Billings, Mont.
Carlsbad	Carlsbad, N. Mex	L. E. Foster	Superintendent	E. W. Shepard	H. J. S. Devries	El Paso, Tex.
Central Valley	Sacramento, Calif	R. S. Calland	Supervising engineer [2]	E. R. Mills	R. J. Coffey	Los Angeles, Calif.
Shasta Dam	Redding, Calif	Ralph Lowry	Construction engineer		R. J. Coffey	Los Angeles, Calif.
Friant division	Friant, Calif	R. B. Williams	Construction engineer		R. J. Coffey	Los Angeles, Calif.
Delta division	Antioch, Calif	Oscar G. Boden	Construction engineer		R. J. Coffey	Los Angeles, Calif.
Colorado-Big Thompson	Estes Park, Colo	Porter J. Preston	Supervising engineer	C. M. Voven	J. R. Alexander	Salt Lake City, Utah.
Colorado River	Austin, Tex	Ernest A. Moritz	Construction engineer	William F. Sha	H. J. S. Devries	El Paso, Tex.
Columbia Basin	Coulee Dam, Wash	F. A. Banks	Supervising engineer	C. B. Funk	B. E. Stoutemyer	Portland, Oreg.
Deschutes	Bend, Oreg	D. S. Stuver	Construction engineer	Noble O. Anderson	B. E. Stoutemyer	Portland, Oreg.
Eden	Rock Springs, Wyo	Thos. R. Smith	Construction engineer	Emanuel V. Hillius	J. R. Alexander	Salt Lake City, Utah.
Gila	Yuma, Ariz	Leo J. Foster	Construction engineer	J. C. Thrailkill	R. J. Coffey	Los Angeles, Calif.
Grand Valley	Grand Junction, Colo	W. J. Chiesman	Superintendent	Emil T. Ficenec	J. R. Alexander	Salt Lake City, Utah.
Humboldt	Reno, Nev	Floyd M. Spencer	Construction engineer [2]		J. R. Alexander	Salt Lake City, Utah.
Kendrick	Casper, Wyo	Irvin J. Matthews	Construction engineer [2]	George W. Lyle	W. J. Burke	Billings, Mont.
Klamath	Klamath Falls, Oreg	B. E. Hayden	Superintendent	W. I. Tingley	B. E. Stoutemyer	Portland, Oreg.
Milk River	Malta, Mont	Harold W. Genger	Superintendent	E. E. Chabot	W. J. Burke	Billings, Mont.
Minidoka	Burley, Idaho	Stanley R. Marean	Superintendent	G. C. Patterson	B. E. Stoutemyer	Portland, Oreg.
Minidoka Power Plant	Rupert, Idaho	S. A. McWilliams	Resident engineer		B. E. Stoutemyer	Portland, Oreg.
Mirage Flats	Hemingford, Nebr	Denton J. Paul	Construction engineer		W. J. Burke	Billings, Mont.
Moon Lake	Provo, Utah	E. O. Larson	Construction engineer	Francis J. Farrell	J. R. Alexander	Salt Lake City, Utah.
North Platte	Guernsey, Wyo	C. F. Gleason	Superintendent of power	A. T. Stimpfig	W. J. Burke	Billings, Mont.
Newton	Newton, Utah	I. Donald Jerman	Resident engineer		J. R. Alexander	Salt Lake City, Utah.
Ogden River	Provo, Utah	E. O. Larson	Construction engineer	Francis J. Farrell	J. R. Alexander	Salt Lake City, Utah.
Orland	Orland, Calif	D. L. Carmody	Superintendent	W. D. Funk	R. J. Coffey	Los Angeles, Calif.
Owyhee	Boise, Idaho	R. J. Newell	Construction engineer	Robert B. Smith	B. E. Stoutemyer	Portland, Oreg.
Parker Dam Power	Parker Dam, Calif		Construction engineer	George B. Snow	R. J. Coffey	Los Angeles, Calif.
Pine River	Vallecito, Colo	Charles A. Burns	Construction engineer	Frank E. Gawn	J. R. Alexander	Salt Lake City, Utah.
Provo River	Provo, Utah	E. O. Larson	Construction engineer	Francis J. Farrell	W. J. Burke	Salt Lake City, Utah.
Rapid Valley	Rapid City, S. Dak	Horace V. Hubbell	Construction engineer	Joseph P. Siebeneicher	J. R. Alexander	Billings, Mont.
Rio Grande	El Paso, Tex	L. R. Fiock	Superintendent	H. H. Berryhill	H. J. S. Devries	El Paso, Tex.
Elephant Butte Power Plant	Elephant Butte, N. Mex	C. O. Dale	Acting resident engineer	H. H. Berryhill	H. J. S. Devries	El Paso, Tex.
Riverton	Riverton, Wyo	H. D. Comstock	Superintendent	C. B. Wentzel	W. J. Burke	Billings, Mont.
San Luis Valley	Monte Vista, Colo	H. F. Bahmeier	Construction engineer		J. R. Alexander	Salt Lake City, Utah.
Shoshone	Powell, Wyo	L. J. Windle	Superintendent [2]	L. J. Windle [2]	W. J. Burke	Billings, Mont.
Heart Mountain division	Cody, Wyo	Walter F. Kemp	Construction engineer	L. J. Windle [2]	W. J. Burke	Billings, Mont.
Sun River	Fairfield, Mont	A. W. Walker	Superintendent		W. J. Burke	Billings, Mont.
Truckee River Storage	Reno, Nev	Floyd M. Spencer	Construction engineer [2]		J. R. Alexander	Salt Lake City, Utah.
Tucumcari	Tucumcari, N. Mex	Harold W. Mutch	Resident engineer	Charles L. Harris	H. J. S. Devries	El Paso, Tex.
Umatilla (McKay Dam)	Pendleton, Oreg	C. L. Tice	Reservoir superintendent		B. E. Stoutemyer	Portland, Oreg.
Uncompahgre: Repairs to canals	Montrose, Colo	Herman R. Elliott	Construction engineer [2]	Ewalt P. Anderson	J. R. Alexander	Salt Lake City, Utah.
Upper Snake River Storage [3]	Burley, Idaho	Stanley R. Marean			B. E. Stoutemyer	Portland, Oreg.
Vale	Vale, Oreg	C. C. Ketchum	Superintendent		B. E. Stoutemyer	Portland, Oreg.
Yakima	Yakima, Wash	J. S. Moore	Superintendent	Alex. S. Harker [2]	B. E. Stoutemyer	Portland, Oreg.
Roza division	Yakima, Wash	Charles E. Crownover	Construction engineer	Alex. S. Harker	B. E. Stoutemyer	Portland, Oreg.
Yuma	Yuma, Ariz	C. B. Elliott	Superintendent	Jacob T. Davenport	R. J. Coffey	Los Angeles, Calif.

[1] Boulder Dam and Power Plant.

[2] Acting.

[3] Island Park and Grassy Lake Dams.

Projects or divisions of projects of Bureau of Reclamation operated by water users

Project	Organization	Office	Operating official		Secretary	
			Name	Title	Name	Address
Baker	Lower Powder River irrigation district	Baker, Oreg	A. Oliver	President	Marion Hewlett	Keating.
Bitter Root [4]	Bitter Root irrigation district	Hamilton, Mont	G. R. Walsh	Manager	Elsie W. Oliva	Hamilton.
Boise [1]	Board of Control	Boise, Idaho	Wm. H. Tuller	Project manager	L. P. Jensen	Boise.
Boise [1]	Black Canyon irrigation district	Notus, Idaho	Chas. W. Holmes	Superintendent	L. M. Watson	Notus.
Burnt River	Burnt River irrigation district	Huntington, Oreg	Edward Sullivan	President	Harold H. Hursh	Huntington.
Frenchtown	Frenchtown irrigation district	Frenchtown, Mont	Tom Sheffer	Superintendent	Ralph P. Scheffer	Huson.
Fruitgrowers Dam	Orchard City irrigation district	Austin, Colo	S. F. Newman	Superintendent	A. W. Lanning	Austin.
Grand Valley Orchard Mesa [3]	Orchard Mesa irrigation district	Grand Junction, Colo	Jack H. Naeve	Superintendent	C. J. McCormick	Grand Jctn.
Humboldt	Pershing County water conservation district	Lovelock, Nev	Roy F. Meffley	Superintendent	C. H. Jones	Lovelock.
Huntley [4]	Huntley Project irrigation district	Ballantine, Mont	E. E. Lewis	Manager	H. S. Elliott	Ballantine.
Hyrum [3]	South Cache W. U. A	Logan, Utah	H. Smith Richards	Superintendent	Harry C. Parker	Logan.
Klamath, Langell Valley [1]	Langell Valley irrigation district	Bonanza, Oreg	Chas. A. Revell	Manager	Chas. A. Revell	Bonanza.
Klamath, Horsefly [1]	Horsefly irrigation district	Bonanza, Oreg	Benson Dixon	President	Dorothy Eyers	Bonanza
Lower Yellowstone [4]	Board of Control	Sidney, Mont	Axel Persson	Manager	Axel Persson	Sidney.
Milk River: Chinook division [4]	Alfalfa Valley irrigation district	Chinook, Mont	A. L. Benton	President	R. H. Clarkson	Chinook.
	Fort Belknap irrigation district	Chinook, Mont	H. B. Bonebright	President	L. V. Bogy	Chinook.
	Zurich irrigation district	Chinook, Mont	C. A. Watkins	President	H. M. Montgomery	Chinook.
	Harlem irrigation district	Harlem, Mont	Thos. M. Everett	President	R. L. Barton	Harlem.
	Paradise Valley irrigation district	Zurich, Mont	C. J. Wurth	President	J. F. Sharples	Zurich.
Minidoka: Gravity [1]	Minidoka irrigation district	Rupert, Idaho	Frank A. Ballard	Manager	O. W. Paul	Rupert.
Pumping	Burley irrigation district	Burley, Idaho	Hugh L. Crawford	Manager	Frank O. Redfield	Burley.
Gooding [1]	Amer. Falls Reserv. Dist. No. 2	Gooding, Idaho	S. T. Baer	Manager	Ida M. Johnson	Gooding.
Moon Lake	Moon Lake W. U. A	Roosevelt, Utah	H. J. Allred	President	Louie Galloway	Roosevelt.
Newlands [3]	Truckee-Carson irrigation district	Fallon, Nev	W. H. Wallace	Manager	H. W. Emergy	Fallon.
North Platte: Interstate division [4]	Pathfinder irrigation district	Mitchell, Nebr	T. W. Parry	Manager	Flora K. Schroeder	Mitchell.
Fort Laramie division [4]	Gering-Fort Laramie irrigation district	Gering, Nebr	W. O. Fleenor	Superintendent	C. G. Klingman	Gering.
Fort Laramie division [4]	Goshen irrigation district	Torrington, Wyo	Floyd M. Roush	Superintendent	Mary E. Harrach	Torrington.
Northport division [4]	Northport irrigation district	Northport, Nebr	Mark Iddings	Manager	Mabel J. Thompson	Bridgeport.
Ogden River	Ogden River W. U. A	Ogden, Utah	David A. Scott	Superintendent	Wm. P. Stephens	Ogden.
Okanogan [1]	Okanogan irrigation district	Okanogan, Wash	Nelson D. Thorp	Manager	Nelson D. Thorp	Okanogan.
Salt River [2]	Salt River Valley W. U. A	Phoenix, Ariz	H. J. Lawson	Superintendent	F. C. Henshaw	Phoenix.
Sanpete: Ephraim division	Ephraim Irrigation Co	Ephraim, Utah	Andrew Hansen	President	John K. Olsen	Ephraim.
Spring City division	Horseshoe Irrigation Co	Spring City, Utah	Vivian Larson	President	James W. Blain	Spring City.
Shoshone: Garland division [4]	Shoshone irrigation district	Powell, Wyo	Paul Nelson	Irrigation superintendent	Harry Barrows	Powell.
Frannie division [4]	Deaver irrigation district	Deaver, Wyo	Floyd Lucas	Manager	R. J. Schwendiman	Deaver.
Stanfield	Stanfield irrigation district	Stanfield, Oreg	Leo F. Clark	Superintendent	F. A. Baker	Stanfield.
Strawberry Valley	Strawberry Water Users' Assn	Payson, Utah	S. W. Grotegut	President	E. G. Breeze	Payson.
Sun River: Fort Shaw division [4]	Fort Shaw irrigation district	Fort Shaw, Mont	C. L. Bailey	Manager	C. L. Bailey	Fort Shaw.
Greenfields division	Greenfields irrigation district	Fairfield, Mont	A. W. Walker	Manager	H. P. Wangen	Fairfield.
Umatilla, East division [1]	Hermiston irrigation district	Hermiston, Oreg	E. D. Martin	Manager	Enos D. Martin	Hermiston.
West division [1]	West Extension irrigation district	Irrigon, Oreg	A. C. Houghton	Manager	A. C. Houghton	Irrigon.
Uncompahgre [3]	Uncompahgre Valley W. U. A	Montrose, Colo	Jesse R. Thompson	Manager	H. D. Galloway	Montrose.
Upper Snake River Storage	Fremont-Madison irrigation district	St. Anthony, Idaho	H. G. Fuller	President	John T. White	St. Anthony.
Weber River	Weber River W. U. A	Ogden, Utah	D. D. Harris	Manager	D. D. Harris	Ogden.
Yakima, Kittitas division [1]	Kittitas reclamation district	Ellensburg, Wash	G. G. Hughes	Manager	G. L. Sterling	Ellensburg.

[1] B. E. Stoutemyer, district counsel, Portland, Oreg.

[2] R. J. Coffey, district counsel, Los Angeles, Calif.

[3] J. R. Alexander, district counsel, Salt Lake City, Utah.

[4] W. J. Burke, district counsel, Billings, Mont.

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